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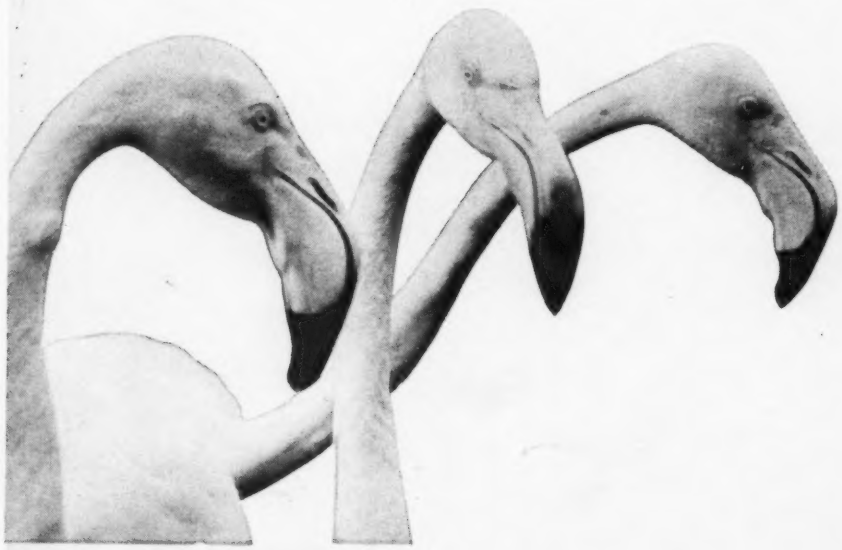

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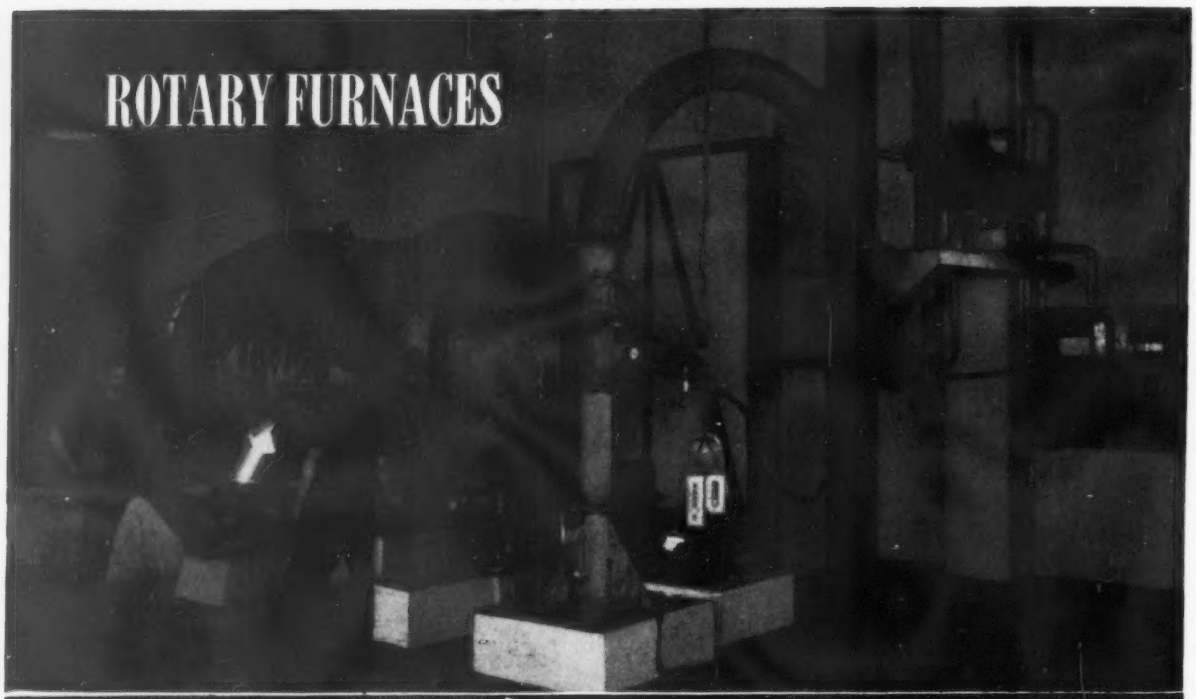

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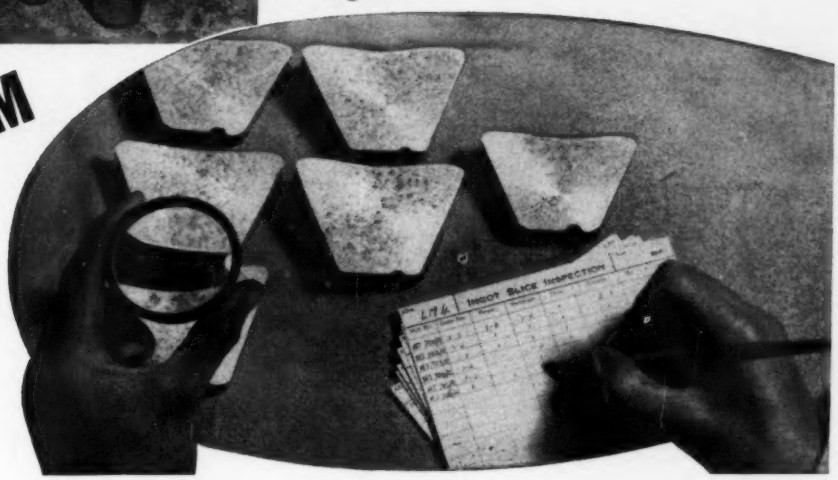

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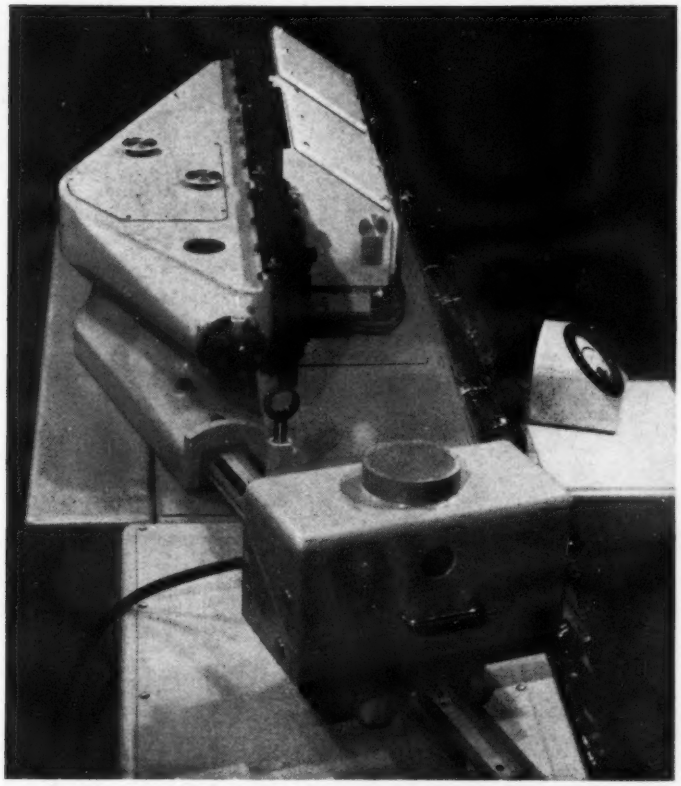

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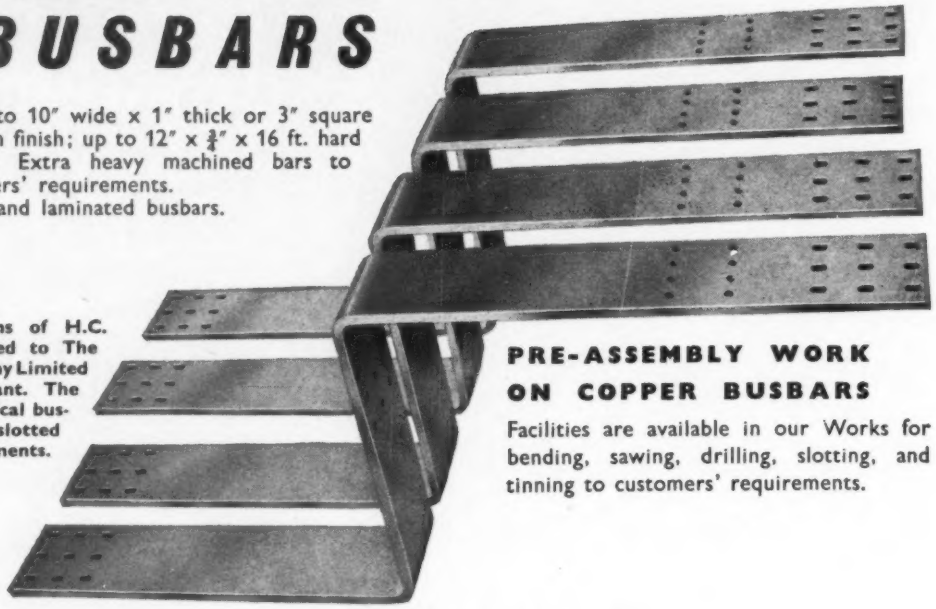

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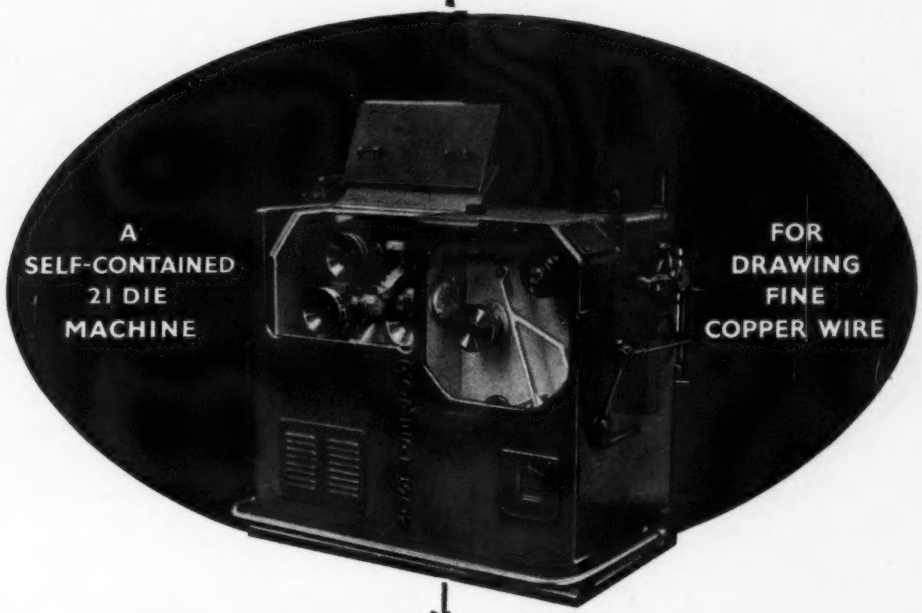

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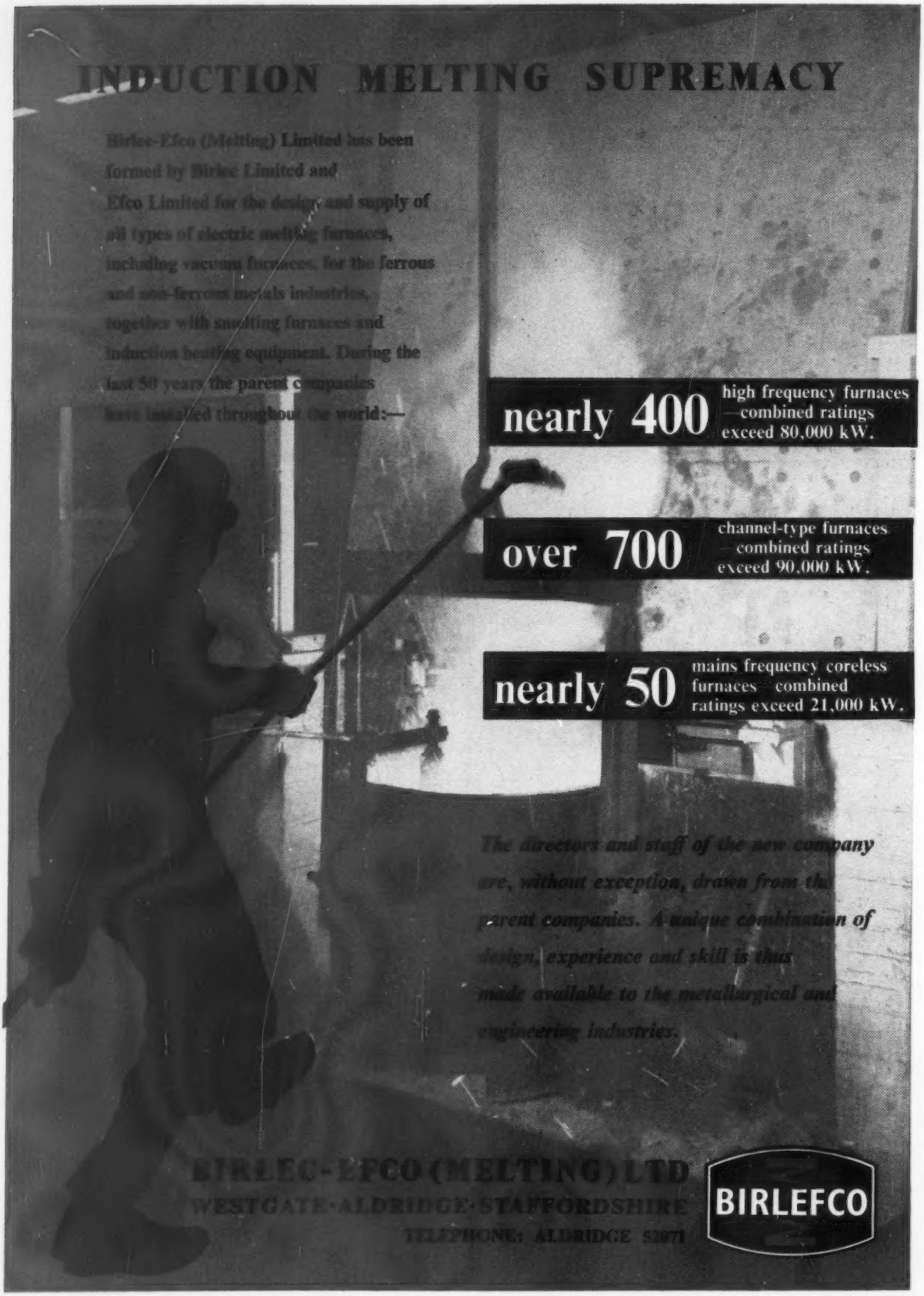
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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

20 FEBRUARY 1959 VOLUME 94 NUMBER 8

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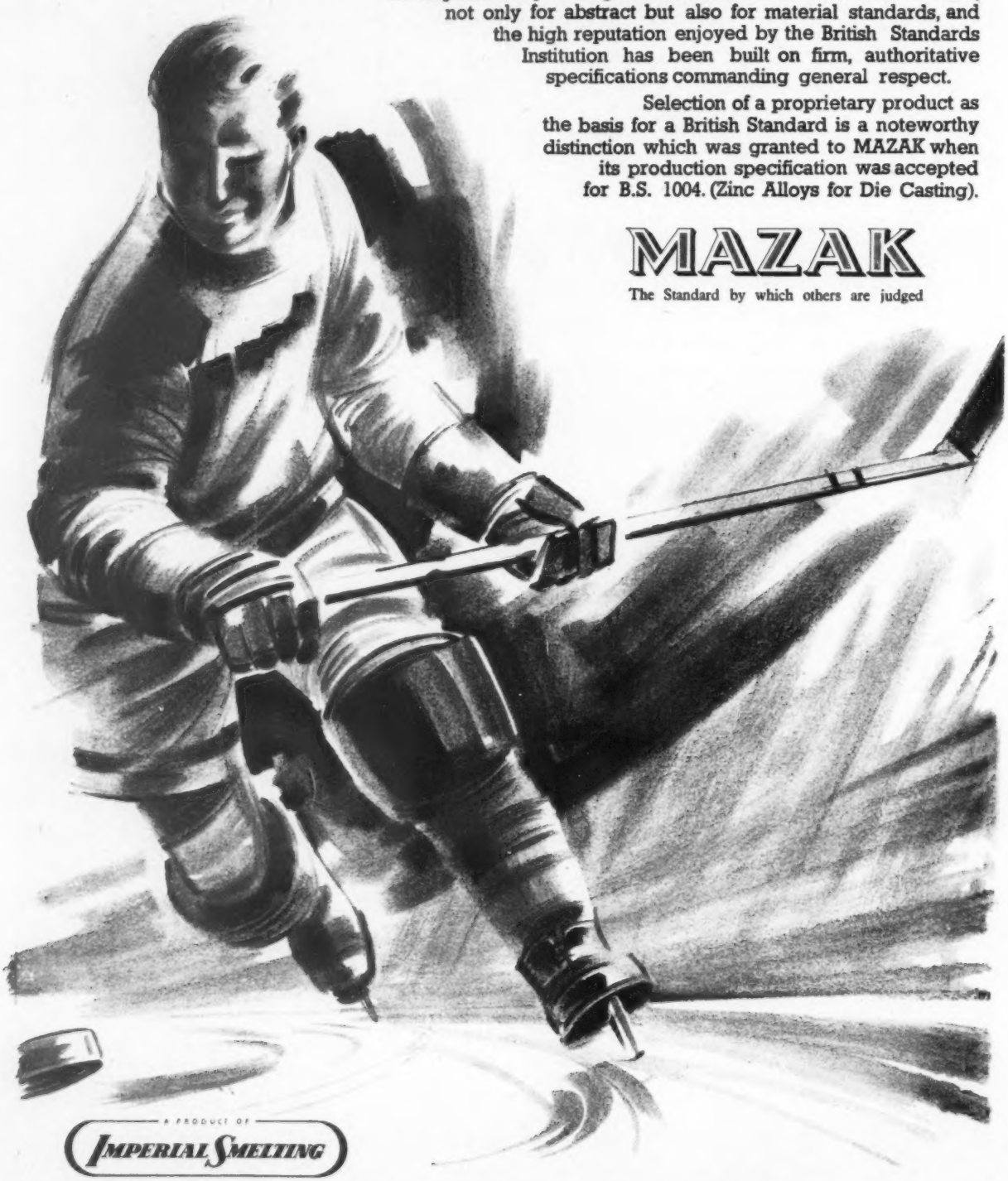

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METAL INDUSTRY

VOLUME 94 NUMBER 8 20 FEBRUARY 1959

Fuel Economy

A CONSIDERABLE number of new buildings which provide accommodation for works machinery, warehouses, offices, and the like are being constructed in large numbers all over the country in these days. Particularly connected with such new buildings is the Thermal Insulation (Industrial Buildings) Act, 1957, which was introduced for application to all new industrial buildings or extensions, the erection of which was proposed on or after January 1, 1959, unless plans had already been submitted to and approved by the local authority before that date, or unless they were exempted by the Regulations, or by the local authority with the consent of the Minister of Power.

The Act has the object of securing greater economy in the use of fuel. Regulations made under the Act prescribe a standard of insulation for the roofs of new industrial buildings and extensions to existing buildings which should secure substantial fuel savings at a reasonable capital cost. There is no doubt that to all industrial firms to-day the question of fuel economy is one of the utmost importance, and no matter whether the fuel concerned is coal, oil, gas, electricity, or what-have-you, fuel conservation is indeed a matter of urgency, not only from a financial point of view but also in the matter of efficiency. The thermal insulation of buildings provides a means whereby substantial fuel savings may be obtained at a reasonable capital cost.

The standard of insulation required by the Act is that the "U" value of the roof (excluding roof lights or openings) must not exceed 0·3. But a "U" value higher than 0·3 is permitted where the "design" temperature (i.e. the temperature required at the working level of 5 ft. from the floor) of a factory is lower than 70°F. In these cases, the standard will be deemed to have been satisfied if the heat loss per square foot of the roof does not exceed 12 B.Th.U. per hour when the outside temperature is 30°F. The amount of heat that passes through the roof structure is affected by the thermal resistance of the materials that make up the structure. In short, the heat loss decreases as the resistance increases. Thus, the "U" value is calculated by first adding together the thermal resistance value of the materials used in the roof structure, and then taking the reciprocal, i.e. dividing the sum of their values into 1. Some examples in calculating this "U" value are given in a useful pamphlet recently issued by the National Industrial Fuel Efficiency Service and which has gone to considerable trouble to provide industrialists with a condensed guide to the Act. For instance, a broad classification of the thermal resistance of a number of insulating materials, calculated on a 1 in. thickness, is given. Then there is also a list of "restricted" materials scheduled by the Regulations. Certain buildings may be exempted from the Act's requirements provided they fall within certain classes. While it is pointed out that there is no obligation to submit plans solely for the purpose of the Act, the buildings erected must comply with its provision, and industrialists who may intend in the near future to extend existing, or build new, factories are advised to submit plans to their local authority for approval of the thermal insulation standards proposed, even if the plans are not to be deposited for other reasons. Local authorities and factory inspectors are empowered to inspect new buildings to see if they comply with the requirements of the Thermal Insulation Act. Where a building has been erected in contravention of the Act, the local authority, by means of a notice, can require the owner to make the necessary alterations or to pull down the building.

Out of the MELTING POT

Merging

GLANCING through the abstracts of the Papers that were due to be presented at the annual meeting, February 15 to 19, in San Francisco, of the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers, a number of impressions may be picked up, one of which derives from the researches on ionic crystals that still tend to stand out against the metallurgical background. The distinction between metals and ionic crystals, though it may appear important to the metallurgist, is a rather arbitrary one, and one becoming more so with silicon, germanium and sundry intermetallic semi-conducting compounds bridging the gap. It is thus quite appropriate to deal in one and the same session with the fracture of chemically-polished magnesium oxide, the ductile-brittle transition in silver chloride, the plastic anisotropy of LiF and other rocksalt-type crystals, and the dislocation theory of fracture in metals. Another Paper described how fatigue processes in ionic crystals have been studied (primarily in magnesium oxide) in a manner paralleling the classical studies of fatigue of aluminium, copper, and other metals. It was observed that, under cyclic stress, dislocations move irreversibly, they multiply, slip bands form and grow, cracks nucleate and propagate, and failure occurs. These processes correspond to processes occurring in metals. The use of ionic crystals in such investigations is advantageous because they are optically transparent, they show stress bi-refringence, and because dislocation intersections with (100) surfaces can be brought out by etching and observed by standard microscope techniques. Another impression from the field of ionic crystals is that the recently-heralded ductility of, for example, magnesium oxide crystals, still remains unpredictable. Of a number of crystals, cleaved from the same parent, a few may deform considerably in bending (up to 15 per cent in the tension surface), while others fracture with no macroscopic deformation whatsoever. It may be whispered that some investigators have even been moved (backwards) to testing crystals while immersed in hot orthophosphoric acid (when there was always considerable deformation before failure).

Straws

IT is always interesting, and in some cases may prove very useful, to take note of the first faint signs of a new trend, new development, or of a new attitude. There have of late been two such stirrings that appear worth noting for the sake of what they seem to foreshadow, and of that into which they may develop. One of them has recently shown up in the American motor car industry in connection with the expected introduction in the not-so-distant future of aluminium engine cylinder heads and blocks, and of aluminium cooling systems. Formerly such a step might have been contemplated as a result of much persuasion on the part of the aluminium industry, and would, in all probability, have been frustrated by the realization that it would entail pitting and galvanic corrosion risks much greater than with existing cast iron components. To-day, on the other hand, the motor industry, having been persuaded or having persuaded itself as to the numerous advantages to be gained from the adoption of aluminium for the above applications, seems to be going on to surmount the risks rather than to dismiss aluminium. It admits that anti-freezes and rust inhibitors, which prevent corrosion in present engines and cooling systems, may not solve the problem in aluminium engines or radiators, but, at the same time, expects the chemical industry to come up with new coolants, or the manufacturers to turn to some other method of cooling, not excluding air cooling. The second of these incipient changes recently to be detected concerns the attitude of metallurgists in particular, and of suppliers of materials in general, in regard to the persistent demands for something better: stronger, lighter, and more heat-resistant. In the past, suitable materials have been forthcoming, or at least could always be promised. To-day, when most of the materials that have been forthcoming in recent years possess certain unfortunate characteristics, promises of something better have on one or two occasions given place to remarks to the effect that metal working will just have to learn to use more brittle materials by adopting suitable design and handling techniques.

Bits for Study

SO far, studies of surfaces of solids, and surfaces of metals in particular, have concentrated on the structural aspects of such surfaces. For various reasons, the chemical composition of surfaces has been rather neglected. Thus, electrochemical characteristics, corrosion behaviour, catalytic effects, sintering phenomena, bonding or adhesion, or lack of it, and various other properties of surfaces, have been glibly ascribed to oxide and other surface films, active centres, cathodic or anodic inclusions, contamination, or to adsorbed layers of this, that, or the other. Some of the ignorance regarding the composition of surfaces, and with it the uncertainty of the many explanations, should be capable of yielding before a determined assault on them by the study of secondary positive ions ejected from surfaces under bombardment by inert gas ions under a suitable potential in a high vacuum. The first attempts recently made in that direction certainly merit being taken up and pursued on a broad front. Essentially, the method involves the use of the surface to be studied as a target for bombardment by inert gas ions produced by electron bombardment, and then accelerated and focused upon the surface. Under this bombardment, particles are ejected from the surface of the target. Some of these may be ionized, while others may be uncharged and may be ionized by an electron beam. Both kinds of particles are then analysed in a mass spectrometer, which forms part of the apparatus. In some exploratory investigations along the above lines, targets of molybdenum, tantalum and platinum have been studied. A contaminated molybdenum surface, for example, i.e. a surface that had not been high-temperature flashed for several days, yielded positive ions of Mo, MoC, MoC_2, MoO_2, Mo_2C, Mo_2C_2 and Mo_2O_2. Impurities derived from platinum surfaces included sodium, potassium, and calcium. For the present, reliable quantitative analyses cannot be made until much more is known about the ionization probabilities of secondary ions. The method of mass analysis of secondary ions should also be able to help in elucidating corrosion, catalysis, and other phenomena in the realm of surface kinetics.

Skimmer

Metal Industry, 20 *February* 1959

Finishing Supplement

Rapid Metal Drying

By F. R. SHERLIKER,
A.R.I.C.

SURFACE-ACTIVE AGENTS FOR USE AFTER AQUEOUS FINISHING PROCESSES

Metal components dried by the process described in this article

PROBLEMS associated with the drying of metal articles after aqueous finishing processes, such as electroplating, bright pickling and phosphating, have in recent years received increasing attention from the metal finisher. In particular, the finisher's concern to increase productivity and decrease labour costs has shown the need for a process that dries brightly-finished, intricately-shaped parts rapidly and without leaving stains.

Conventional methods of drying in ovens or heated centrifugal dryers suffer from the basic disadvantage that some, at least, of the water is removed by direct evaporation from the metal surface, and impurities present in the water are deposited on the surface, so giving rise to water stains. Such stains are frequently formed, for instance, on chromium-plated articles even after thorough rinsing in soft natural water, and their removal involves a final manual wiping or polishing operation. A further drying problem arises with parts that hold water by capillary attraction, for example, wire gauze components, hinges, and fine bore tubes; in these cases, conventional drying methods can be laborious and time-consuming.

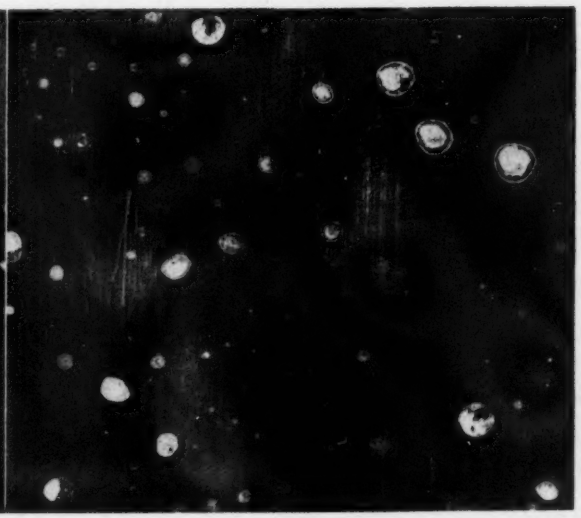
If the water film, instead of being evaporated directly, could be completely displaced from the surface and then removed by evaporation, the above problems could be overcome. Examples of physical processes whereby one liquid present on a surface is displaced by a second liquid are quite well known. In the metal finishing field, for example, the use of alkaline cleaning solutions which displace mineral oil films from metal surfaces, and the use of dewatering oils which displace a water film, are commonplace. Indeed, drying is frequently carried out by the latter process—the oil film, in turn, being removed by trichloroethylene or perchloroethylene degreasing. If the solid surface could be preferentially wetted by a volatile solvent such as trichloroethylene or perchloroethylene, this two-stage drying process could be reduced to one stage.

If a metal surface is cleaned and washed in running water until, on withdrawal, an even water film, free from breaks, is obtained, and the plate is then immersed in either the liquid or vapour of trichloroethylene, the film contracts into droplets as a result of the high interfacial tension which exists between the two liquids (Fig. 1). Water evaporates in either solvent vapour or boiling solvent, but water stains remain at the droplet sites (Fig. 2).

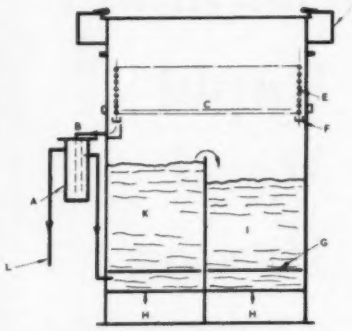
Recent work has shown that cationic surface-active agents, dissolved in a

Fig. 1—A water film on a sheet of metal in trichloroethylene contracting into droplets

Fig. 2—Typical water stains formed by the evaporation of droplets on a metal surface



Left: Fig. 3—The water film on a metal plate being displaced by trichloroethylene containing "Trisec" metal drying assistant



A—Water separator. B—Distillate. C—Vapour level. D—Rim ventilation. E—Condensing coils. F—Trough. G—Work support plates. H—Heat. I—Drying compartment. K—Rinsing compartment. L—Separated water to drain.

Right: Fig. 4—Diagram of cross-section of a drying plant for use with trichloroethylene and "Trisec" metal drying assistant

solvent such as trichloroethylene (or perchloroethylene) are strongly adsorbed at the surface of solids such as metals or glass. This means that the organic solvent preferentially wets the solid and displaces the water film. Water and trichloroethylene form a constant boiling mixture (or azeotrope) with a boiling point of 73°C.—nearly 14°C. below that of the solvent by itself. If a piece of wet metal is immersed in boiling trichloroethylene containing a suitable surface-active agent, the surface moisture, together with any dissolved solids, is displaced immediately (Fig. 3), leaving a perfectly clean surface. The displaced water mixes with solvent, and forms an azeotropic mixture that rapidly boils away and removes the water. Obviously this system forms the basis of an efficient process for drying metal articles, and one that overcomes many of the disadvantages inherent in existing methods.

In practice, this new drying process can be carried out conveniently in a simple, slightly modified trichloroethylene degreasing plant. A diagram of the plant arrangement is shown in Fig. 4. It consists of a heated tank divided into two compartments by a weir plate. The first compartment contains trichloroethylene and a suitable cationic surface-active additive (for example, "Trisec" metal drying assistant) and the second compartment contains only trichloroethylene. Baskets or jigs of wet work are dried by immersion in the first compartment for 20 to 30 sec., and are then transferred to the second compartment, where they are rinsed free of additive in clean solvent. Vapour rising from both compartments is condensed on a peripheral condensing coil and falls into a trough. This leads into the water separator, where water is continuously separated, allowing pure solvent to return to the second compartment of the plant. A rather deeper freeboard is required on a drying plant than is usual on a degreasing plant. In addition, a simple rim ventilation system is fitted. For maximum service life, the unit should be made of stainless steel, but a satisfactory life for a relatively low initial cost can be obtained from mild steel, hot galvanized after fabrication.

Plant operation is simple, and presents no difficulty to those already familiar with trichloroethylene degreasing. The same handling techniques that are employed in degreasing are used, with little modification, in solvent drying. It is important that work should be arranged so that it is free-draining to avoid drag-out of solvent; some shapes that give trouble in this respect may need rotating in a suitably designed basket. Plant maintenance is uncomplicated; the solvent must be kept at the correct level in the drying compartment. Addition of the metal drying assistant, "Trisec," is usually necessary only after the plant has been cleaned out and recharged. This may be after several weeks or several months, depending on operating conditions.

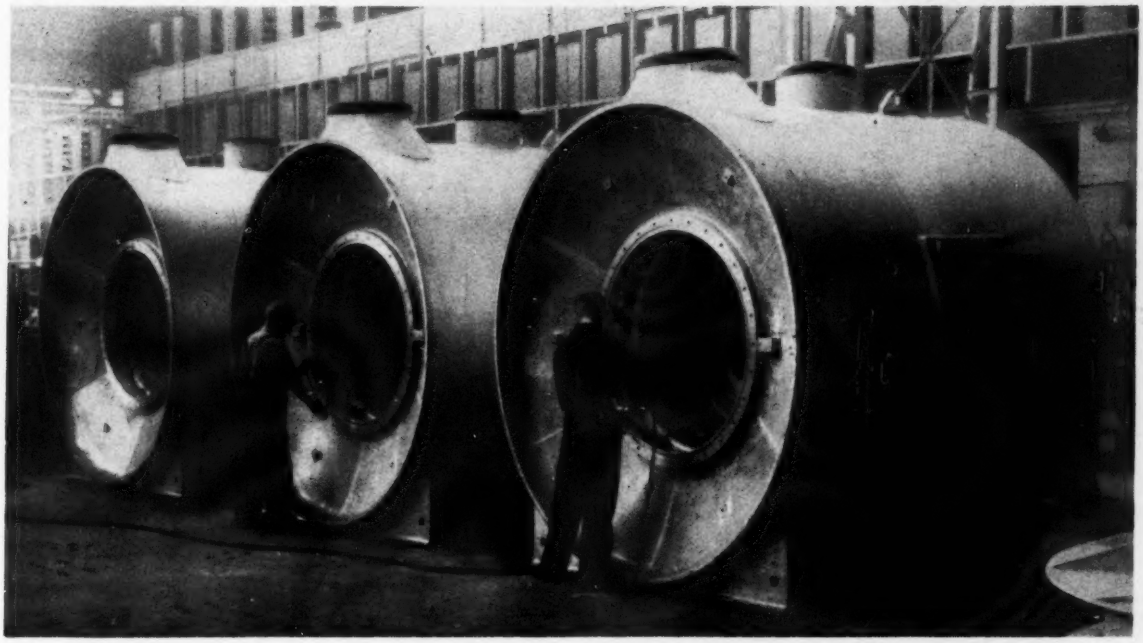
Of the two commercially-available solvents possessing suitable physical and chemical properties — trichloroethylene and perchloroethylene — the former is preferred because of its lower price and lower heating requirements. Perchloroethylene, while offering the theoretical advantages of a higher boiling point, is not so economical for general use. Where the highest possible rate of water removal is required, a system based on perchloroethylene may be preferred, but the two solvents are dissimilar in structure and properties, and it cannot be assumed that a metal drying additive that is efficient in one will be equally efficient in the other.

Practical experience has shown that a drying plant of the type described above, having a total solvent charge of about 35 gal. of trichloroethylene, together with the recommended concentration of "Trisec" metal drying assistant in the drying compartment, removes between about 1 and 1½ gal. of water per hr., depending on the method of heating. An electrically-heated plant of this size normally consumes 11·1 kW, and a steam-heated plant 82 lb/hr. of dry steam at 30 lb/in². This is adequate for the throughput of a medium-sized electroplating shop. These figures have been determined by measuring the amount of water discharged from the water separator (i.e. distilled from the drying compartment). The rate at which water is removed from the work is many times greater than this. It is important to note here that the proof of a good metal drying assistant lies in its ability to promote rapid stain-free drying, even when free water is present in the solvent. A highly efficient additive and a plant in which the work is treated in batches, allow a much higher drying rate than that given above for continuous drying. This is because water continues to distil from the drying compartment while the plant is idling between batches.

In a short article, it is only possible to suggest a few applications that await this new process. Although primarily developed for the stain-free drying of electroplated and other parts, it is finding increasing use where speedy or complete drying is the prime essential. Examples are the drying of phosphated components before spirit staining or painting, and the drying of parts which, after heat-treatment in molten salt baths, have been washed in water. While the major outlets will undoubtedly be in the metal finishing field, other materials, such as glass and ceramics, may be treated, provided they are not adversely affected by boiling trichloroethylene.

Experience gathered from a variety of applications during the past twelve months shows that substantial savings may be achieved. In most cases these arise from lower reject rates of finished parts, and in the elimination of labour costs caused by manual wiping or polishing operations. In the future, solvent drying plants are likely to become an essential part of most aqueous finishing processes. With more and more automation, manually-operated plants will probably give way to mechanized or fully-automatic plants.

"Trisec" is a registered trade mark of Imperial Chemical Industries Limited.



Three examples of a device fabricated in aluminium for the U.K.A.E.A. and known as the S.250. It weighs 4¼ tons

Heavy Aluminium Fabrications

FAIREY AVIATION COMPANY'S WORK AT STOCKPORT FOR THE U.K.A.E.A.

OVER the last eighteen months there has been evidence of many companies, whose sole pre-occupation before was the production of aircraft, looking to other kinds of work to absorb their surplus productive capacity. For the past ten years Fairey Aviation has been strongly involved in other kinds of work, and has thus been able to re-organize its capacity and abilities.

At the Heaton Chapel (Stockport) works, physical evidence is provided of the company's achievements in the field of aluminium and steel fabrication and welding. Specialized techniques are now practised where once only conventional methods were used. These techniques have been developed over the past decade, so that the result to-day is the production of components and parts finished to a high degree and standard. Production of aluminium fabrications has reached the figure of between 80 to 100 tons a month, which indicates some extent of the activity at this branch factory.

A large proportion of the work has been devoted to producing equipment for the Atomic Energy Authority.

Among this work for the Atomic Energy Authority is a device called the "S 250." It can best be described as a large aluminium shell consisting of six major fabrications. Material for these is obtained from both Northern Aluminium Co. Ltd. and the British Aluminium Company.

Two departments at Stockport are particularly concerned with the production of these devices, as they handle most of the output. These two departments are known respectively as the Machine Tool Division, which is responsible for welding, machining and assembly, while the Press Shop is concerned with the routing of forms, forming and rolling. Each section works in close liaison with the other, an essential factor in smooth production.

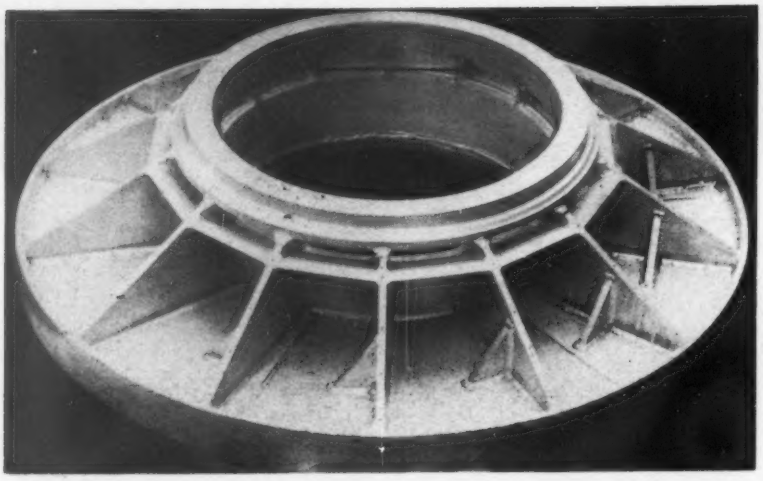
The devices have large domed ends, which are formed in six petal-sections that are first routed and formed on a hydraulic press and subsequently welded together after tacking in a jig. These end-pieces have a central core, joined to the rest of the fabrication by web-like side-frames. Another part of the device is a motor mounting, a fabrication of some 18 to 19 cwt. which requires, apart from the segmented plate work, the rolling, welding and hydraulic forming of conical rings, and the forming and welding of very heavy section bars. The whole welded assembly was specially developed to replace and improve on the casting technique originally envisaged for this job.

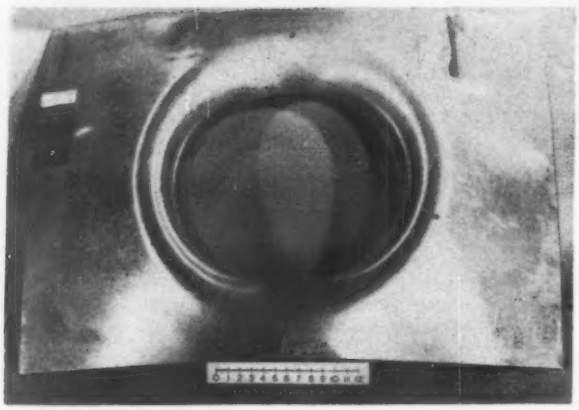
These fabrications are welded into their cylindrical housings, resulting in a boiler-like structure some 10 ft. high and 12 ft. long. The total weight is just over 4½ tons complete, which tends to belie the fact that it has been made up from aluminium parts.

A four-piece outlet forms a part of the device and this is formed on a rubber bolster press, which the company did not originally intend for such work, but which has proved valuable for this nuclear-age task. The 4,000-ton bolster press has as its most important feature 21 in. of rubber, which permits the forming of parts half of this depth, or approximately 10 in. Apart from being employed on the work for the S.250, this press has seen more recent use producing motor-car body pressings, for which the company has held a contract.

So far as routing is concerned—and this is an important job on the device—the company's skilled knowledge of aircraft manufacture has proved invaluable, for it is essential that near-perfect fitting of the parts in the housing be achieved.

The only steel that is used on the S.250 is that in the feet which support the job. These, again, are made by the Stockport factory. One point that has not hitherto been made is that "clean conditions" must be maintained in the workshop and floor area, as might be expected when near-pure materials are being used for such a special job. No





Above—An aluminium welded fabrication in A.W.5 material. Diameter is 8 ft. 6 in. and weight 18 cwt. The base is made from 1¾ in. thick rolled plate. The webs are about 1 in. thick

Left—A large rubber bolster pressing in half-inch A.W.5 sheet

impurities can be allowed to penetrate into the job during fabrication, and after a certain stage, therefore, the housing is screened-off in plastics booths. Work is then continued under the tent-like structure housing the job.

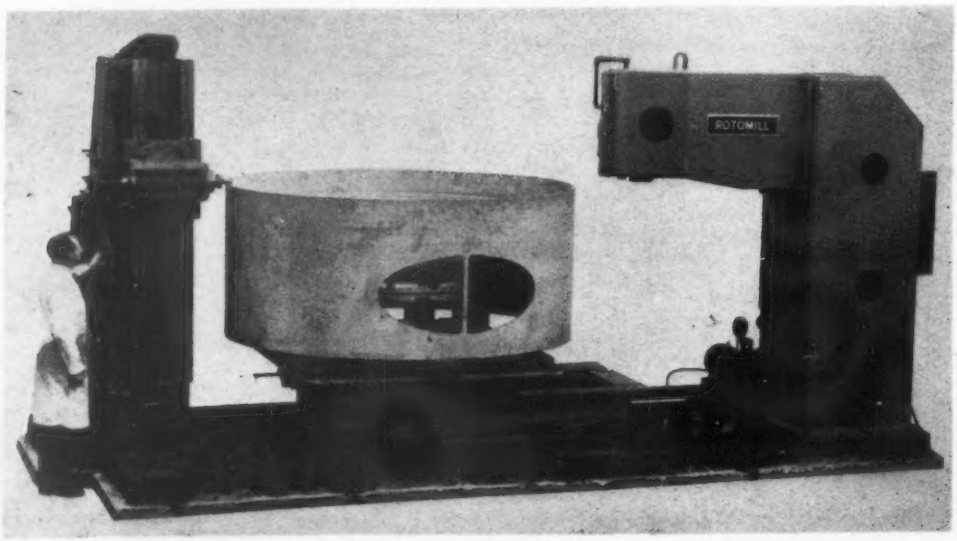
The two welding processes employed by the company at Heaton Chapel form an essential part of the work, and much of the fabrication of parts is dependent on the welding.

Considerable research and development work has been performed by Fairey's on the welding of aluminium structures, and both argon arc and Argonaut techniques have been, and are, employed. Five-inch welds are now made as routine, although when the first five-inch weld was performed at Heaton Chapel it was something of an event, for it had never been attempted before. The material welded was originally intended to be produced as part of a large casting. Since so much was to be gained by eliminating the difficulties associated with castings of this kind, the attempt was made.

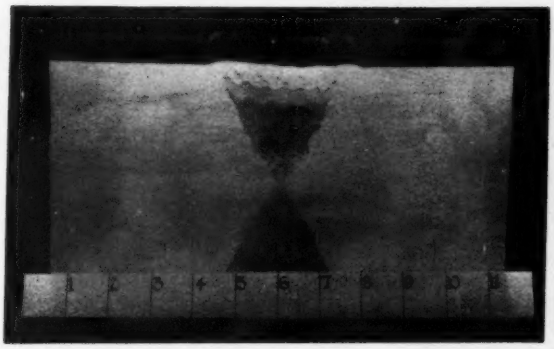
With the Argonaut technique, which is used mainly in the production of the S.250 device, the material used in the weld (N6 wire alloy) is fed through the welding gun automatically from a store positioned above the operator. Three wire thicknesses are used, $\frac{3}{64}$ in., $\frac{1}{16}$ in. and $\frac{5}{32}$ in., and these are fed at a rate of some 230 in/min. The welding guns are water-cooled, as are the cables of the welding unit. The electric power for the motor feeding (pushing) this material supply through the gun is provided from a separate power unit—the output being 250 amp. for $\frac{1}{16}$ in. thick wire and 350 amp. for that $\frac{5}{32}$ in. in thickness.

Argon gas, which is stored in liquid form in a central tank, is supplied through tubes to all the Argonaut welding guns about the shop. A pressure of 40 lb. from the tank permits a supply which enables welders to work at the rate of 45 ft^3/hr. Argon consumption is about 12,000 ft^3/week. The 5 in. welds noted earlier are carried out by the Argonaut process.

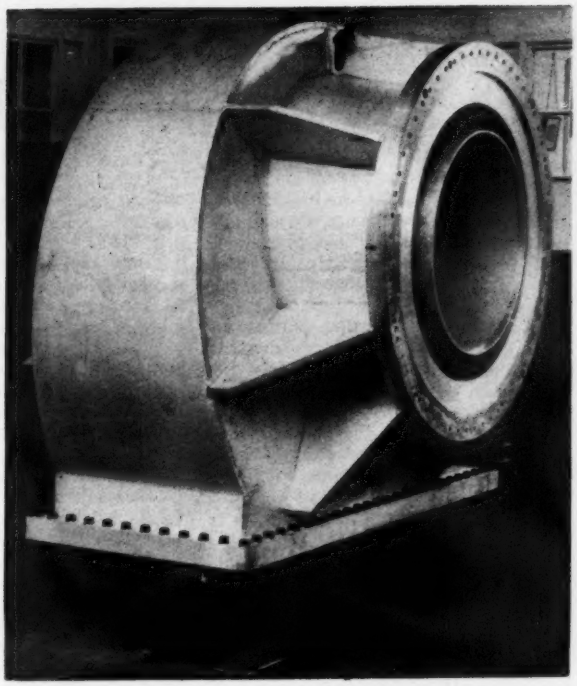
Because of the size of parts under fabrication at the works, various manipulators, rotators, plate rolls and the like are required to handle the work for welding and for assembly. Many of these form part of the stock of equipment at Heaton Chapel, and this equipment also includes facilities for lifting up to 30 tons weight. There is also a large stress-relieving furnace installed.



Rotomill designed and manufactured at Heaton Chapel for use on large aluminium fabrications such as the 8 ft. 6 in. dia. component shown on the worktable



Typical weld on A.W.5 aluminium alloy 5¾ in. thick. It has very high strength and is free from porosity



Aluminium welded fabrication weighing 2 tons, built for the U.K.A.E.A.

In the case of routing, radial arm machines are used, with 5 h.p. heads, for work on plates of 1⅛ in. thickness. For special purposes, involving repetitive work, equipment has been developed such as the Rotomill, which has two high-speed cutting heads for removing the stock at a high rate when machining large aluminium components.

Attention has been given here mainly to the fabrication of aluminium and aluminium-alloy structures currently concerning the company. It is important to note, however, that Fairey Aviation has fabricated, in steel and stainless steel, units of considerable importance to such bodies as the Atomic Energy Authority. These have included structures of up to 80 ft. length, such as the scanning gear for the original Windscale reactor, and the core of the Dounreay reactor, which was built literally to toolroom tolerances.

Men and Metals

Changes in the structure of two of their subsidiary companies have been announced by Sheepbridge Engineering Limited. **Mr. R. W. T. Bray** has severed his connection with Bray Construction Equipment Limited, of Feltham, and **Mr. D. J. Harrowell,** formerly technical director, takes over as managing director. **Mr. W. J. Collard,** who was transferred from the company some years ago to an appointment as director and general manager of Harold Andrews Sheepbridge Limited, now returns to Feltham as commercial director. Mr. Collard's duties as general manager at Harold Andrews Sheepbridge Limited, of Halesowen, are being taken over by **Mr. B. C. Goodwin,** formerly sales manager of that company.

Recent activities of the directors of Edgar Allen and Company Limited include the overseas tour now being made by **Mr. L. K. Everitt** and **Mr. W. J. McBride,** who are visiting South Africa and Rhodesia. Later, Mr. McBride is to attend the opening in Iran, by the Shah of Persia, of the new cement factory, equipment for which has been largely supplied by the company.

Manager of the trackwork department of Edgar Allen and Company Limited, **Mr. D. P. Carr** has been elected chairman of the Sheffield branch of the Permanent Way Institution for this year. Mr. Carr, who has been connected with the Institution since 1925, was previously chairman in 1950.

In connection with the formation of a new Division on Materials Sciences by the American Society for Testing Materials, **Mr. K. B. Woods,** head of the School of Civil Engineering, Purdue University, U.S.A., has been appointed President of the Division; **Mr. F. L. LaQue,** vice-president and manager, Development and Research Division of The International Nickel Company Inc., and **Mr. A. Allan Bates,** vice-president of Research and Development of Portland Cement Association, to be vice-presidents of the Division, with **Mr. Robert J. Painter** as executive secretary.

Appointed assistant manager of the group purchasing department of the Wakefield Castrol Group. **Mr. S. H. Oliver** joined W. B. Dick and Company Limited in 1932, and entered his present department when that company became a member of the Wakefield Group.

It is announced that **Mr. G. R. Bell** has been appointed general manager of the British Division of Wall Colmonoy (Canada) Limited, which manufactures Colmonoy hard surfacing and corrosion-resisting alloys for application by normal welding techniques, or by the Colmonoy Sprayweld process, and also markets the complete range of Nicrobraz high-temperature brazing materials. Mr. Bell will be responsible for the company's entire European operations.

Appointments to the boards of their subsidiary companies recently announced by Head Wrightson and Company Limited are as follows:—**Mr. George Taylor** and **Mr. John D. Eccles** as directors of Head Wrightson Steel Foundries Limited; **Mr. Roger B. W. Bolland** as a director of Head Wrightson Colliery Engineering Limited; and **Mr. Richard O'Brien,** D.S.O., M.C., as a director of Head Wrightson Stockton Forge Limited.

Changes in the board of Rhodes, Brydon and Youatt Limited have been announced as follows:—After forty-three years' service with the company, **Mr. C. S. Youatt** has relinquished his position as deputy chairman but continues as a director; **Mr. A. H. Parkes** has been appointed deputy chairman, and **Mr. R. L. Furnival** has resigned from the board of the subsidiary company — Furnival and Company Limited. **Mr. Harry Aston** has been elected to the board of directors and takes up his appointment as chief engineer to both companies next month.

Atomic Progress

Zirconium Alloys

THE low neutron absorption cross-section of zirconium makes it of potential importance for use in nuclear reactors. The principal interest in zirconium alloys in current U.K. reactor designs is for support or structural members. This is because feasibility studies show that zirconium alloys compare unfavourably with magnesium as a canning material for CO_2-cooled graphite moderated reactors. A zirconium alloy (Zircalloy) has been used as a fuel cladding in pressurized water reactors. A Paper[1] which dealt with the development of oxidation-resistant zirconium alloys was presented at the Geneva Conference, and is the subject of this review.

Alloy Additions

Oxidation tests on sponge-base zirconium have shown it to be unsuitable for use at 500°C., whereas iodide zirconium might be acceptable. The use of the latter is undesirable on economic grounds, and provides an incentive for the development of more oxidation-resistant sponge-base alloys. Wagner's theory of thick film formation and the semi-conduction characteristics of zirconia formed the basis for recommending small additions of Group V and VIA elements, such as niobium, tantalum, chromium, molybdenum and tungsten, to reduce the anion defect concentration in the oxide lattice. The effects of tin, iron, chromium and nickel, which had been beneficial to the corrosion characteristics of zirconium in high pressure water, were also studied.

Niobium, tantalum, molybdenum and tungsten all gave improved oxidation behaviour at the 0·25 atomic per cent level. The improved behaviour was retained with additions of molybdenum and tungsten up to 1·5 atomic per cent, even though this exceeds the limit of solid solubility. Correspondingly good oxidation resistance is not observed with similar larger additions of niobium or tantalum, which do not form intermetallic compounds with zirconium.

Tin was found to be innocuous at levels up to 0·5 atomic per cent, but seriously deleterious at levels above this. Aluminium and silicon were seriously deleterious. Nickel, iron and chromium were beneficial in small amounts but detrimental in larger quantities.

Two other additions, copper and beryllium, were both found to be beneficial. Addition of the former at the 1·0 atomic per cent level gave the optimum improvement of all the alloys examined. The effect of copper additions cannot be described in terms of simple ideas of anion vacancy effects.

The effect of water vapour in the CO_2 on zirconium-beryllium alloys was unusual in that at 500°C. the weight gain was doubled after 5,000 hr. exposure. This might be related to the behaviour of beryllium in wet CO_2; a further study of zirconium-beryllium alloys would be of great interest.

Ternary additions to zirconium-copper alloys did not give significant improvements, although some gain in film coherence was obtained from small additions of beryllium, chromium, iron, and molybdenum. The most promising alloy, when creep resistance is also taken into account, contains 1·0 wt. per cent copper and 1·5 wt. per cent molybdenum.

Nitrogen has a catastrophic effect on aqueous corrosion, but up to about 300 p.p.m. has a minor effect on gas corrosion. Carbon in solution does not have adverse effects in gaseous corrosion, but the presence of carbide rosettes seems to accelerate corrosion. Table I gives examples of the change of corrosion of various alloys compared with sponge zirconium in CO_2 at 500°C. and 8 atmos. pressure.

The authors conclude that outstanding improvements in the oxidation resistance of zirconium in gaseous media are not to be expected, and that improvements greater than a factor of 2 will not be forthcoming at any temperature, although improved film adherence in the post transition period has been achieved. In view of this, and despite any improvements in creep resistance which alloying may effect, the use of zirconium in CO_2-cooled reactors in excess of 500°C. cannot be visualized.

Oxidation Law

Analysis shows that the initial protective oxidation follows a rate law of the type $w=kt^n$. This is associated with the formation of a black adherent monoclinic oxide film. After a weight gain of about 0·9 mg/cm., a white non-adherent oxide, with the same monoclinic structure, appears on the surface and the rate law becomes more-or-less linear. This change in rate can be followed by "break-away" of the oxide film.

Rate-Transition and Breakaway

Rate-transitions occur after shorter times at higher temperatures. Dilute additions may affect the time at which the transition occurs, or modify the mechanical properties of the oxide film, so that it may be coherent in the post-transition state and not subject to breakaway. Thermal cycling accelerates the onset of breakaway. Work on isothermal scaling led the authors to conclude that there is some critical weight gain above which one thermal cycling operation is sufficient to cause film breakdown. The authors associate the rate change with mechanical failure of the underlying oxygen-rich metal, which tends to disrupt the contiguous oxide film when the critical rupture strain at that temperature is exceeded.

Oxidation Mechanism

There are at least three polymorphic transformations of zirconia—cubic, tetragonal, monoclinic. The modification generally reported, and observed by the authors, during oxidation of metallic zirconium, is the monoclinic form. The volume ratio of oxide to metal is greater than unity, and the monoclinic oxide has a more open lattice than the cubic and tetragonal oxides. These properties are necessary, but not sufficient, for the formation of a protective oxide film. A more important criterion is the amount of distortion involved for epitaxial oxide growth to occur at the metal surface. Comparison of lattice spacings in the metal and oxide indicate a lattice misfit of rather more than 12 per cent. This means that the film initially formed on zirconium will be under considerable compressive stress. The high symmetry possible for ionic compounds of the type AB_2, the cation valency of 4, essential for this type of lattice, the

(*Continued on page* 152)

TABLE I—CHANGE OF CORROSION

	Corrosion Factor	Alloy (Atomic per cent)
More Resistant	2·0	Tungsten 1; Molybdenum 0·25
	1·80-1·89	Copper 1·5
	1·50-1·59	Niobium 0·25; Nickel 0·25
	1·20-1·29	Chromium 0·25; Copper 1; Iron 0·25
Sponge	1·0	Chromium 0·25 ; Niobium 0·5
Less Resistant	0·80-0·89	Chromium 1·5
	0·50-0·59	Tin 1; Tantalum 0·5
	0·30-0·39	Tin 1·5

Corrosion factor = Wt gain sponge ÷ wt gain alloy at 100 days.

POSITIONING CAVITIES FOR CASTINGS WITH THREE OR MORE ELEMENTS

Design of Die-Castings

X—Cams, Gears and Components of Mechanisms

By H. K. BARTON

ONE of the fastest expanding fields of application for die-castings is that of small precision mechanisms, which embraces a wide variety of actual products ranging from computer and accounting machine parts to coin-in-the-slot vending equipment. In many instances housings and structural parts, as well as the mechanical elements, are produced by die-casting, but the latter may be singled out for special attention since they often embody components combining a high degree of intricacy and precision with a piece-part cost that, compared with the products of other processes, is often fantastically low. There have, in fact, been very many occasions when only the economy with which parts of complicated form can be produced as die-castings has made the introduction of a new product possible.

In previous articles of this series attention has been directed, in passing, to various small mechanical parts illustrative of specific principles in design, but it is proposed on this occasion to deal with such components in a less piecemeal fashion and to show, so far as possible, the enormous scope that they open up to the designer. In the development of small mechanisms the working parts often undergo so many functional modifications, and suffer so many *ad hoc* additions and amputations, that it is sometimes difficult to see how the components of the prototype can be reduced to forms suited to quantity production by any method. It is a merit of die-casting that contours and profiles which appear wildly improbable can be produced just as quickly and cheaply as more conventional shapes.

Three-Element Forms

A good example of this, notable in that although the form is complex the die-casting is technically extremely simple to cast, is the two-lobe cam of Fig. 1, with its integrally-formed ratchet wheel. Although this component is relatively small, it would be almost impossible to manufacture it by any other process in one piece and maintain, without machining, the required lobe profiles. As may be seen, these are scalloped to provide a series of positive dwell positions—corresponding to successive ratchet indexings—for a follower.

Structurally, the cam consists of three elements, each flat and of constant thickness. These are the actual cam-lobes, the ratchet-wheel, and the thin circular diaphragm separating them. This last is not, however, primarily a functional element; it serves only to shroud the ratchet and simplify the profile for trimming, a design feature discussed at length in a previous article. Both the cam-lobes and the ratchet could be easily stamped from steel sheet, though this would have to be of stout gauge in order to get a satisfactorily large pressure area at the edges.

Various means of assembling the parts are practicable; they might, for example, be united by pressing a central bush into punched holes in both elements, and then spot-welding the lobes to the ratchet-wheel. Quite apart, however, from the extra operations such a method of production demands, it also calls for a rather critical angular setting of the lobes *vis-à-vis* the ratchet. By any process producing a one-piece component this last requirement is eliminated; the advantage of die-casting in this particular application is that it not only eliminates assembly and produces a smoother working face on the cams, but involves only a relatively low tool cost, since the piece can be produced at a fast rate from a simple two-part die.

For component parts of small mechanisms such as this, though initial tool cost is an important factor, it is also necessary to bear in mind the likely cost of tool alterations necessitated by design changes. Because of their very simplicity, blanking dies do not lend themselves readily to changes of profile, whereas die-casting die cavities—especially when, as here, of constant depth—can be extensively modified with little difficulty. Moreover, the die need be out of production little longer than the actual time taken to mill the new contour—possibly less than half a shift.

Not all design changes need necessarily involve any structural die alteration. In the case of the two-lobe cam, the angular relation between the various scallops on the cams, and the successive stops of the ratchet, determines the set of the two engaging components, the ratchet-dog and the cam-follower. Should it become necessary to alter the dimensions, or the centres of oscillation, of either of these parts, the angular relation between ratchet and cam-lobe must be corrected to maintain the position of the other one.

In the case of a built-up component, where it might appear that this could be achieved with greatest facility, the change calls, in fact, for rebuilding the nesting fixture used to hold the pieces in the desired position at assembly. In the die-casting, the alteration need involve only an adjustment of the

Fig. 1—Diverse mechanical elements can often be combined in a single die-casting, as in this cam and ratchet-stop

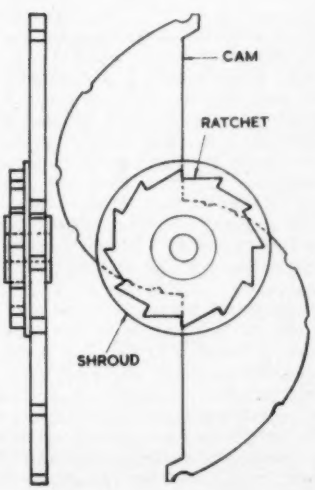
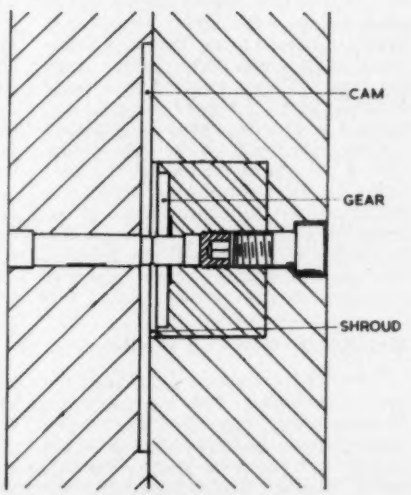


Fig. 2—Simple two-part die with cam-lobe cavity in fixed member and the gear cavity sunk in a separate insert secured in the moving member. The shroud is formed by setting back the face of the cylindrical insert



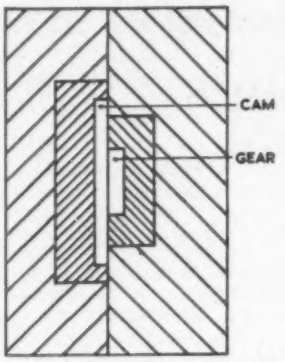


Fig. 3—Here cam and gear cavities are both formed within demountable inserts, which may be removed severally from the die and replaced by other carrying cavities that differ in detailed form

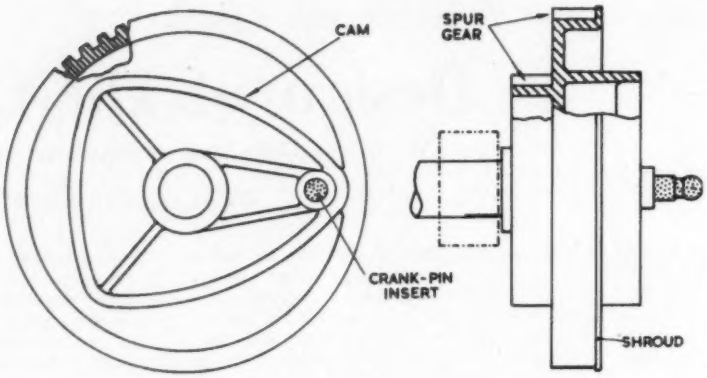


Fig. 5—Two spur-gears, a camming surface and a crank-pin with steel insert are here cast as a single unit

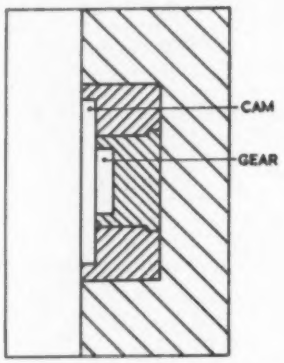


Fig. 4—A composite insert contains the milled cam cavity and a smaller hobbed gear cavity

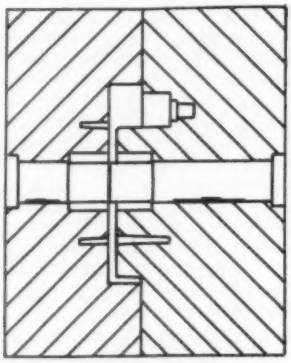


Fig. 6—Cavity disposition to produce the component of Fig. 5 from a two-part die

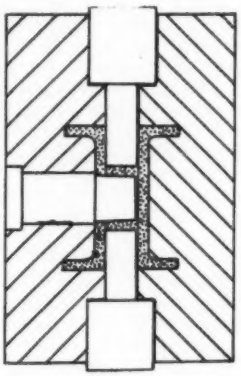


Fig. 7—Undercuts between mechanical elements demand the use of lateral slides in the plane of the die-parting

cavity insert within which the ratchet is formed, and if the likelihood of any such alteration is envisaged, the die-caster can often construct the tool in such a way that it does not need to be completely removed from the machine in order to make the adjustment.

A part-section through a tool of this sort is seen in Fig. 2, and whilst the cam-lobe cavity is sunk direct in the fixed die member (left), the ratchet cavity is formed in the face of a cylindrical cavity insert let into the main die block. This is retained by a single large-diameter cap screw at its centre, so that it can be angularly displaced without removal from the die. Below (i.e. to the left in the figure), the cap-screw is a short socket-head grub-screw which is screwed tightly home in the threaded hole. The purpose of this is merely to provide in the simplest manner a hexagonal socket whereby the insert may be rotated.

Relative Position of Elements

To alter the angular position of the ratchet, therefore, it is only necessary to slack off the cap-screw one or two turns, tap the insert forward to free it of any carbonized oil in the joint that might impede rotation, remove the cap-screw and, with a hexagon key, rotate the insert into the new position. This is, of course, checked from the face of the die. The cap-screw is now replaced and the insert drawn back into its new position. The whole operation requires only five or ten minutes per cavity to carry out.

Various small elaborations of this basic procedure are called for on occasion. It is usually desirable to provide a set-screw bearing upon the side of the insert; after a sample casting has been checked for correct angular adjustment, the set-screw is tightened down to prevent accidental displacement. If, as is sometimes the case, a series of, say, three distinct components, differing only in the angular relation of their parts, is called for, three positive locations for the inserts are needed. These may be determined by, e.g. the engagement of a single dowel in the die by one of three alternative holes in the insert.

As will be evident from the construction of the tool in Fig. 2, it is not only possible to index the ratchet into different angular positions with regard to the cam-lobes but, if desired, it is equally simple to take out the ratchet cavity insert and replace it by one of different type, as, for example, a ratchet of six stops instead of twelve. By this means a series of composite components, identical in the cam elements but differing in the size of the integrally-formed ratchets, can be produced from a single tool and a set of interchangeable inserts.

In the tool illustrated, the lobe-cam is a constant element and is sunk direct in the die-block. This is usual in the case of small single-cavity dies, where the cam-cavity may be expected to occupy a large part of the die face, but in other circumstances this cavity also is best sunk in a separate insert. If the lobe-cam is not a constant element, a separate insert should be adopted even in a single-cavity tool (Fig. 3). Such a die permits the production of a whole family of mechanical elements, functionally related but structurally distinct, from a single tool. Thus, a tool with two cam inserts and three ratchet inserts (or any equivalent pairs of elements), with the latter indexable to any one of four positions, is capable of producing twenty-four distinct components. In practice, no doubt, some of the possible combinations would not be called for, but if only half of them have functional value the economy of the method is well established.

In a simple, two-part die there is no

restriction whatever on the relative shapes and sizes of the elements formed in each die half, apart from the obvious one that they must be conformable at the die parting. If, however, interchangeable inserts are to be used, it is highly desirable that the elements should be designed in such a way that the die parting can lie in a plane. If this is not done—and certainly there do, very rarely, arise circumstances in which it is impracticable—the matching of the faces of all the inserts becomes difficult.

Referring again to Fig. 1, it is easily seen that the tool designer has no option but to sink the lobe-cam cavity in one die member, and the ratchet wheel together with the thin disc of the shroud in the other. This is because each element overlaps the other; i.e. looking at the component from either side, parts of both elements are visible. If the ratchet were so small that it did not project beyond the cam, for example, it would be possible to sink both elements in one die member.

This possibility is of considerable importance, since all the combinations of cam and ratchet discussed above would still be achievable even were both elements formed in the same die half, subject only to their sizes and shapes not varying enough to cause an overlap (which, of course, would result in an undercut within the die-cavity). As an example, Fig. 4 shows a cam and gear formed wholly within the moving die member; the gear cavity is sunk in a separate cylindrical plug set into the insert bearing the cam cavity. In this particular case the latter is also cylindrical, though generally this would not be so.

The formation of both cam and gear in the same die member has, of course, the advantage that concentricity between the two elements can be held to even closer limits than when the two are formed in opposite die halves; moreover, there is no diminution of accuracy as the guide-pins and bushes become worn. In a tool of this sort it is generally desirable to remove it completely from the die and strip it down on the bench when inserts are to be interchanged, so that very short runs of particular pairs of elements are less acceptable than with tools like that of Fig. 2.

It may be noted at this point that, even though the interchange of inserts is not contemplated, the die-caster may still prefer to use a built-up cavity, as in Fig. 4, merely to facilitate die-sinking. Thus it may happen that, whereas the main portion of the cavity (here, that forming the cam) is milled out, the smaller part, represented by the gear, is of so finely detailed a nature that it is best hobbed to form. Any damage or erosion of the fine detail can then be countered by replacing the hobbed insert by another from the same hob.

More Complex Forms

Although there is no limit to the number of separate mechanical elements that can be formed integrally, in practice it is seldom that more than four or five are so combined. The exceptions relate largely to regularly stepped assemblies, such as clusters of spur gears (where as many as nine gears have been integrally die-cast) and to discrete components which, though not connected to each other, are cast in a prescribed relationship to each other along a rod or tube inserted into the die. The first calls for little comment and the second is considered in more detail below.

Most assemblies of three or four mechanical elements can, with some ingenuity of design, be brought to a form in which they are susceptible of production in a two-part die. This often entails a regrouping of elements and, of course, the exigencies of die construction are likely to enforce, or at any rate make desirable, a particular arrangement of the elements in the group. Thus, if the elements that it is desired to combine are, respectively, a driven gear rotating the whole group, a driving gear engaging another assembly, an external cam track and a crank-pin, the relative positions of these are determined in part by function and in part by size and form.

Such a group is illustrated in the drawing of Fig. 5, where it is shown mounted on one end of a shaft adjacent to a bearing bracket. Such a position is unavoidable, since the crank-pin must be so placed as to allow its connecting rod a full circular sweep, and this entails forming it on an end-face of the assembly. The relative positions of the other three elements determine the location of the die-parting, but this must, in any case, lie to one side or the other of the largest element—in this instance, the driven gear.

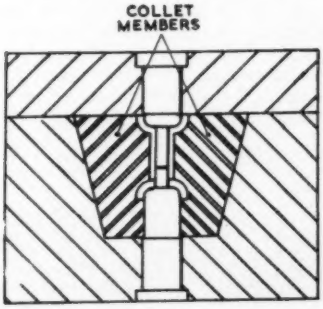
In this connection the designer should bear in mind the desirability, if circumstances allow, of forming nominally concentric gears in the same die member. If they are formed in opposite members, concentricity may still be held to within, say, 0·006 in., but even if the actual eccentricity is only half of this, it still results in more wear of the geared elements, the shaft-centres being fixed, than when both gears are formed in one die-block. Thus, unless there is some real functional disadvantage the gears should be cast on the same side of the die-parting, as shown in the die section of Fig. 6.

The location of the cam-track is thus fixed, for, since its radius of curvature is at some points less, and at others greater, than that of the smaller gear, it can lie neither to the left of the latter, nor between the two gears, without creating an undercut. It must accordingly be formed to the right of the larger gear, between the latter and the crank-pin. It may be noted that, had the pitch radius of the crank-pin been somewhat less than here shown, the whole assembly could have been reversed and the pin formed integrally with the smaller gear.

Undercut Forms

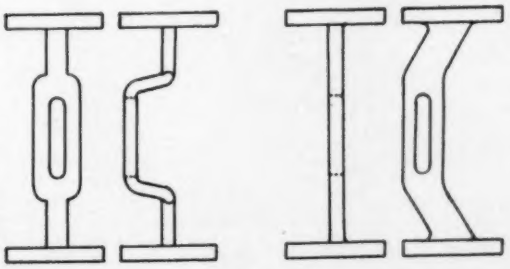
So far all the components considered have avowedly been restricted to elements that could be grouped in such a way as to allow production from a two-part die, without recourse to lateral slides or other methods of forming undercuts. However, there are sometimes functional reasons preventing a satisfactory grouping, or even dictating the use of profiles which cannot be grouped in any way (bearing in mind that the angular relation between rotating or oscillating elements is always predetermined) that will avoid an undercut.

This is the case, for example, when any one of the elements is a vee-groove pulley or the like, when any camming element has a smaller radius of curvature than either of the adjacent elements and, rarely, when a hole radial to the axis of the group (an oil-hole in the side of a boss, for example) must be cored rather than drilled. All such instances call for the use of a tool with at least one lateral slide, and very



Left: Fig. 8—In a collet die the effective parting-plane lies between the two collet members and not between the main die blocks

Right: Fig. 9—Because it calls for an irregular parting, the component on the left with its cranked strap is unsuitable for production in a collet die, although the somewhat similar piece on the right presents no difficulties



commonly with a pair of opposed slides, as indicated in the die section of Fig. 7.

A tool of this sort consists of three distinct zones, within which the possible shapes that can be formed, and the accuracy with which dimensions can be held, vary appreciably. Within each of the main die members there are virtually no restrictions on the intricacy of the profile of the cavity, and intra-cavity dimensions are substantially invariant. Within the lateral slides, by contrast, only elements of simple profile with few re-entrant portions can be cast; this enables most simple camming surfaces to be formed, but does not admit the formation of ratchets or gears.

Thus, whilst it is possible to form, for example, an integral group consisting of a pair of concentric spur gears with an integral crank-pin surface between them, one could not similarly group a pair of large cams with a small gear-wheel. It should be noted, too, that the crank-pin surface being formed by two sliding members, a few thousandths of an inch ovality may occur, whereas a similar surface formed wholly within one of the main die-blocks would run perfectly true. Most applications embodying lateral slides are, accordingly, concerned with spool-like components in which the flange elements are the functional ones, the intermediate portion being in the nature of a spacer or hub.

As a general rule, the method of Fig 7 is used for all but the very smallest assemblies. For parts weighing only an ounce or so, however, die-casters often prefer to use what are generally termed "collet" dies when reel-like assemblies are called for. A section through a typical collet die is given in Fig. 8; the tool usually has from four to eight cavities arranged along the plane of the collet parting.

One advantage of a collet die is that it enables close limits to be held across the parting, for the wedging of the collet halves in their housing holds them rigidly together when metal is injected. Another is that, in general, it permits the provision of a greater number of die cavities than would be practicable in a tool of the same area, but with the cavities sunk in the main die members. This is because in such a tool sliding cores would be needed to form the end-faces which, in Fig. 8, are formed by fixed cores.

Against these, a disadvantage is that the whole profile of the component—ends as well as centre portion—must be of fairly simple form and free from undercuts. Additionally, since it is not good practice to have anything other than an absolutely flat collet parting, the parting-line on the component must lie all in one plane. This rules out some quite simple combinations of mechanical elements—such, for example, as that of Fig. 9, left. The form on the right is, by contrast, quite practicable.

(To be concluded)

Visual Surface Measurement

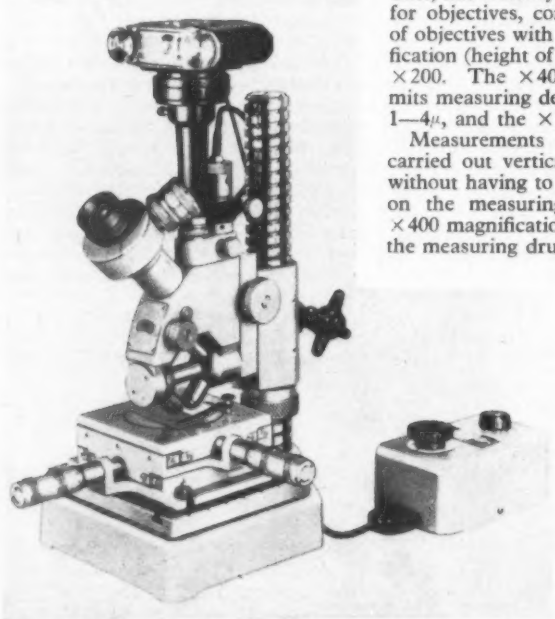
A LIGHT section microscope, the first of its kind imported into the U.K., is being installed in the Blackburn works of Mullard Ltd., where it will be used to check the surface smoothness of production parts in all branches of industry. While ordinary microscopes enlarge the image of the surface without providing depth measurement, the light section microscope allows for accurate measurement of ripples and grooves without having to touch or damage the test piece.

The microscope combines an illumination and an observation microscope at right-angles to each other and 45° to the test piece. In this way, a "profile" observation or photograph can be obtained. The instrument also contains a reticule, with a vertical and horizontal cross-line visible in the eyepiece. By operating the measuring drum, it is possible to obtain the depth of any roughness present by measuring the difference between the peak and the trough in the profile image, utilizing the horizontal cross-line, and the distance between ripples or grooves by utilizing the vertical cross-line. The profile may also be recorded on a photograph.

The microscope, a Carl Zeiss product, has a newly-developed nosepiece for objectives, consisting of two pairs of objectives with a microscope magnification (height of profile) of ×400 and ×200. The ×400 magnification permits measuring depths of roughness of 1—4μ, and the ×200 permits 3—100μ.

Measurements of contours can be carried out vertically and horizontally without having to convert the readings on the measuring drum. With the ×400 magnification, one graduation of the measuring drum equals 0·5μ, while with the ×200 magnification one graduation equals 1μ at the object.

An added feature in the microscope is a centre cradle designed for the rotation and close examination of turned parts, with centre openings up to a diameter of 60 mm. For other cylindrical work, a U-bearing on a mechanical stage is available.



The Carl Zeiss light section microscope fitted with camera for recording the image of the profile

Atomic Progress

—*continued from page* 148

low electrostatic energy and the minimum degree of misfit in relation to the metallic zirconium appear to favour the formation of the cubic oxide. On the other hand, the cation-ion radius ratio of 0·62 is below the minimum postulated for the fluorite type of structure by Pauling. The monoclinic structure actually observed is a distorted form of the fluorite lattice.

A Russian Paper[2] presented at Geneva is of interest here because the results quoted are at variance with those in the British Paper. The Russian workers report that, by means of electron diffraction techniques, they have detected polymorphic transformations in the oxide films formed on massive zirconium alloys. They suggest that breakaway is associated with the polymorphic change from tetragonal to monoclinic structure. An explanation of this discrepancy may be that the Russian work was performed on thin foils of zirconium, which oxidized completely, and any effect due to the underlying metal was lost.

References

[1] W. G. O'Driscoll, T. Raine and C. Tyzack; Geneva Conference Paper A/Conf. 15/P/1450.

[2] I. I. Korobkov *et al*; Geneva Conference Paper A/Conf. 15/P/2054.

Industrial News *Home and Overseas*

Forthcoming Event

At the Savoy Hotel, London, on Tuesday, March 3 next, the annual dinner and cabaret of the **London and Southern Scrap Iron and Non-Ferrous Metal Merchants' Association** will be held. The function is timed for 6 p.m. for 6.45 p.m.

Essay Competition

Sponsored by the publication *Research*, the Waverley Gold Medal Essay Competition is being held for the seventh year in succession. This competition is designed to encourage and promote improved and more effective reports of scientific and technical work.

The Gold Medal, with £100, will be awarded for the best essay of about 3,000 words describing a new scientific project or practical development giving an outline of the scientific background, the experimental results, and the potential application of the project or process in industry. The essays will be judged for technical content, by specialists in the subject, for clarity of presentation and style.

A second prize of £50 will be awarded, and also a special prize of £50 for the best entry from a competitor under the age of thirty on July 31 this year. The competition is open only to persons engaged in scientific work from January 1 to July 31 this year. Complete details may be obtained from the Editor of *Research*, 4-5 Bell Yard, London, W.C.2.

A New Division

In order to co-ordinate and develop knowledge of fundamentals of materials, the American Society for Testing Materials is to organize a new division which will collect and publish basic information essential to a better understanding of materials and their properties. The division is to be known as the **Division on Materials Sciences,** and it will also provide a meeting ground for scientists and engineers.

Inspection Equipment

An order for automatic ultrasonic inspection equipment to the value of £10,000 has been placed with **Kelvin Hughes (Industrial) Ltd.** by Kovo, the Czechoslovakian buying organization, through Exico of London. The equipment will facilitate the rapid scanning of rolled mild steel bars for internal defects, and consists of a remote control console containing the C.R.T. presentation and recording equipment, and the remote operating controls for a scanning unit situated above the main feed conveyor.

Hand and Clothing Monitor

Recently introduced by **E.M.I. Electronics Ltd.,** the hand and clothing monitor to safeguard those engaged in duties which expose them to atomic radiation, is already engaging the serious attention of atomic energy authorities. We understand that orders have already been received from the U.K. and other countries

This instrument is stated to be particularly suitable for tropical and sub-tropical climates, as the use of dual phosphor scintillation counters increases efficiency in humid environments. Alpha and beta contamination of both hands is detected simultaneously, reducing the hand count to 5 sec. At the same time, other personnel can use the clothing and footwear probes. Automatic correction for background gamma radiation of up to 0·5 milliroentgens/hr., eliminates tedious zeroing procedures, and no skill is required to use the instrument.

Separate meter readings are given for alpha and beta contamination of each hand, and for clothing and footwear. These readings remain until the next users automatically reset them to zero. Audible and visible warnings operate if the maximum permissible contamination level is exceeded, or if the hands are removed before the end of the count period.

Industrial Process Cleaning

Ultrasonic and electrolytic equipment for the factory cleaning of parts prior to plating, painting and finishing will be seen in operation on the stand (E.40) of the **Electrical Development Association** at the Factory Equipment Exhibition, to be held at Earls Court, London, in April. An example will be shown of a cabinet type 3 kW ultrasonic cleaner for use with either chlorinated or aqueous based cleaning solutions to cover a wide variety of cleaning applications.

Also to be seen will be a cleaner providing a modified form of impact blasting, using abrasive suspended in a liquid which is delivered to a blasting nozzle by means of a high pressure circulating pump. The cleaner imparts a satin polished finish, down to 4 micro in., depending upon the type of material being processed.

Finally, a plant will be demonstrated for electropolishing parts, in which the surface is given a final polish by an electrochemical process after an initial polishing by mechanical means. This plant also provides for electrolytic deburring, which is especially useful for awkward "inside" edges.

New Laboratories

In the past ten years, the volume of research and development work in **Wakefield-Dick's** laboratories at Hayes, Middx., has increased some 300 per cent. A large extension to the laboratories has now been opened, completely equipped with the most modern apparatus used for research on lubricating oils and allied products.

Electrical Engineers Exhibition

On Stand No. F.18 at the forthcoming A.S.E.E. Exhibition, to be held at Earls Court, London, during March next, the control gear division of **G.W.B. Furnaces Ltd.** will be displaying a selection of Star/Delta motor starter panels of 10 h.p., 300 h.p., and 470 h.p., and also stator rotor starters of 7 h.p. and 50 h.p., which are being supplied to an urban district council for sewage pump work.

A further multi-motor panel will be shown housing direct-on-line starters, this panel being tropicalized for export to India, where it will be used for controlling steel mill auxiliaries. Open frame works, on which will be mounted a selection of the standard range of contactors and isolators up to 1,400 amps, will enable visitors to the stand to examine in detail these items.

Aluminium Plant and Spain

Recent news from Madrid states that the Spanish Ministry of Industry has rejected a proposal by Aluminio Iberico to set up an aluminium refinery near Madrid. One of the major reasons given for the refusal was that Spain's foreign currency reserves were not in a state to permit the import of the equipment required. Furthermore, the Ministry said, it would be better to await completion of other projects and see whether their output would be adequate to cover Spain's industrial demand. If this was not the case, there would still be time to reconsider the rejected project.

In the meantime, Aluminio Iberico is building an aluminium refinery at Vigo, in collaboration with Aluminum Limited of Canada.

Move to New Factory

Recent impressive increases in the demand for the sintered metal products of **The Morgan Crucible Co. Ltd.** have led to a move to larger premises. The sales office has been moved to Wandsworth Works, Point Pleasant, Wandsworth, London, S.W.18, and a new factory and laboratory established there for the production and development of Sinterlink. This combines plant and facilities previously situated at Battersea and Norton, Worcester.

Phase I of the move has now been completed, and has been carried out without interruption of output (in fact, output has been stepped up). When the next and final stage is completed—by the middle of the year—production capacity will be available on a much increased scale.

Ultrasonic Inspection

A free technical service has been instituted by **The Ultrasonoscope Co. (London) Ltd.,** to advise on all aspects of ultrasonic flaw detection and inspection. Based on many years' experience in this field, the company will be able to recommend techniques and advise on the feasibility of applying ultrasonic inspection to any particular problem. To this end they are prepared to investigate samples and to advise on technical suggestions, submitted by firms who feel there is a potential application for ultrasonic inspection in their works.

Companies having enquiries and problems relating to the inspection of billets, forgings, welds, plates, extrusions, and certain castings (such as rolls) are invited to contact The Ultrasonoscope Co.

A Ventilation Conference

Eighty delegates from all the area offices of **Colt Ventilation Ltd.** in the United Kingdom will attend the head offices of the company at Surbiton, Surrey, for the annual two-day conference to be held on March 5 and 6 next.

During the following month (April) the company is making a special display on Stand No. C.24 at the Factory Equipment Exhibition. The theme of the exhibit is

"Ventilation in the Service of Industry," and the items contained in the exhibit will show the benefit of ventilation to industry, why a properly balanced and scientifically planned system is the most economical, and the free consultative service Colt offer to industrialists with a ventilation or heating problem.

Ease of fixing, good design and appearance will be displayed in the unit ventilators and heaters comprised in the Colt system, which will be built into this stand in typical industrial building constructions. The Colt ventilators in high-grade durable aluminium are effortlessly controlled by quality pneumatic, screw-rod, electrical or cord controls, all of which may be operated by visitors to the stand.

New Aluminium Smelter

It was recently announced by **Aluminium Limited** that the inauguration had taken place, by the Indian Aluminium Company Ltd., of a new aluminium smelter at Hirakud, in Orissa State, which more than doubles India's capacity for the production of primary aluminium. Aluminium Limited said the new smelter had an annual capacity of 11,200 tons of aluminium. Built at a capital cost of 10 million dollars, the smelter formed part of a 30 million dollar integrated expansion project involving bauxite, alumina, metal production and fabrication.

The Indian company is said to be considering plans to expand the Hirakud smelter to 22,400 tons capacity. Aluminium Limited has a 61 per cent interest in the Indian company and the remainder is held by Indian shareholders.

An Extrusion Press for Brazil

A 500 ton horizontal Hypactor press, manufactured by **Fielding and Platt Limited,** is shortly to be installed in Sao Paulo by Industria Yorkshire Do Brazil. The Hypactor, which is fully automatic, is being supplied as a complete extrusion plant, and will be used chiefly for the cold extrusion of aluminium and aluminium alloy tubes and architectural sections; it is equipped with a hydro-electric accumulator and pumping system of Fielding design and manufacture. High ram speeds and other special design features enable this press to produce hollow sections in lengths of up to 40 ft. Solid sections of even greater length can also be produced, the maximum length of these being dependent on the size of the cross-section. The high throughput rate of 300 extrusions/hr., using the Crittall-Luxfer cold extrusion process, considerably reduces production costs.

News from Scotland

It is reported from Glasgow that **British Chrome and Chemicals Limited** are modernizing and redeveloping their plant on a site across the Glasgow Road, Shawfield, from the previous factory. Plant is being transferred from the older unit and supplemented by new equipment.

A new factory for **Cockburns (Springs) Ltd.** (a subsidiary of Cockburns Ltd.) is to be located at Meiklewood Road, Glasgow, and is being equipped with four gas-fired furnaces, coiling, annealing, blasting, testing and coating plant to produce springs for shipbuilding, petroleum, chemical, engineering and allied industries.

Etching Primer

An announcement from **Federated Paints Ltd.** is to the effect that their new Strathclyde etching primer PA-10 is now Admiralty approved. This primer is a metal conditioner with a phenomenal adhesion. The makers claim that it does not require costly pre-treatment, and that it provides a durable etch bonded coat on aluminium sheeting, zinc sprayed metals, shot-blasted steel, and on all ferrous and non-ferrous metals.

It is stated that it air-dries in 30 min., applied by brush, dip or spray, and that its stability ensures the uninterrupted application by spray gun essential in automation. Sample tins for test purposes may be obtained free from the manufacturers.

Specialized Brazing

A new service to industry has recently been introduced by **Newton Victor Ltd.,** the X-ray department of Metropolitan-Vickers Co. Ltd., in the form of specialized brazing. This service is being provided at the department's works at Finchley, where specialized brazing plant is used in the manufacture of X-ray tubes and valves.

The plant provides for the high quality brazing of components in controlled atmospheres and under vacuum. It includes radiation and muffle furnaces, with which temperatures up to about 1,800°C. can be achieved, so that no torch or flame is needed; these furnaces will handle parts up to approximately 3½ in. square, and up to 10 in. in length. There are also "eddy current" furnaces, which give fairly local heating and temperatures in excess of 1,100°C., and which are suitable for the brazing of circular components; these will deal with items up to 3½ in. in diameter, and up to 3 ft. 6 in. in length.

The joints catered for include stainless steel to stainless steel; stainless steel to steel; copper to steel; steel to steel; copper to copper; steel to Nilo K; and Monel to other metals. A method of brazing beryllium has also been developed, and applications for tungsten brazing can be investigated.

Welding News

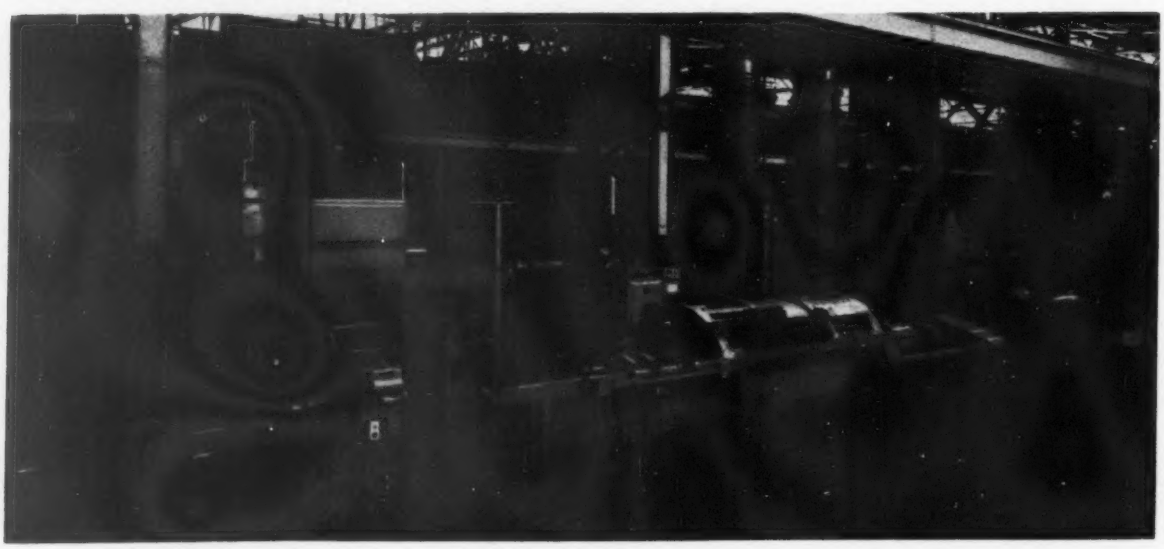
On March 12 next, when Sir Leonard Owen, managing director of the U.K. Atomic Energy Authority, delivers the second annual lecture of the **Institute of Welding,** on the subject of "Welding and the Nuclear Power Programme," members of the Institute will, no doubt, learn not only how welding has met the demands for perfect fusion of new metals to operate at temperatures and under service conditions once thought prohibitive, but also something of the puzzles which welding technology is likely to be called upon to solve in the next few years.

The lecture will be given at the headquarters of the institute, 54 Princes Gate, Exhibition Road, London, S.W.7. Admission is by ticket, obtainable from the secretary of the institute.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses fell by 723 tons at the end of last week, and were distributed

A 500 ton Hypactor cold extrusion press, similar to that which Fielding and Platt Ltd. are supplying to Industria Yorkshire Do Brazil, for use in Sao Paulo. (Picture is by courtesy of the British Aluminium Co. Ltd.)



as follows:—London, 5,857 tons; Liverpool, 6,451; and Hull, 1,430 tons.

Stocks of refined copper rose by 740 tons, distributed as follows:—London, 2,149 tons; Liverpool, 2,634; Birmingham, 177; and Manchester, 1,375 tons.

Tin Shipments

Singapore tin shipments in the first half of February totalled 56½ tons, according to the Straits Trading Company. This compares with 31¾ tons in the first half of January and 812¾ tons in the first half of February last year. Of this month's shipments, the United States took ten tons, Europe four, the Pacific 27¼, and India 15 tons.

Penang shipments during the same period amounted to 1,458¼ tons, against 1,467¾ and 1,798 tons respectively. Of the first-half February Penang shipments, the United States took 855 tons, Europe 135, Japan 238, India 87¼, South America 35, Australasia 95, and the Middle East 12½ tons.

Aluminium Foil Plant

Finska Kabelfabriken A/B of Helsinki has concluded an agreement with Svenska Metallverken of Sweden to set up a mill for the production of aluminium foil at Kaineby, near Nurmjaervi.

The Swedish company will supply the new concern, which will be called Aluma Oy, with aluminium strip.

Metal Finishing

Advance notice has been issued of the annual conference of the **Institute of Metal Finishing,** which is to be held this year at the Hotel Metropole, Brighton, from April 8 to 11. Technical sessions will be held during the first three days, and a most comprehensive selection of Papers is to be presented. On the morning of the final day (Saturday) members will be left free to arrange private discussions.

An informal social programme has been arranged, and on the evening of the first day a reception and dance, by invitation of the Mayor and Corporation of Brighton, has been arranged. The annual dinner and dance will be held on the evening of Friday, April 10, and a programme of events for the entertainment of the ladies during the conference period has also been arranged.

The Fifth Hothersall Memorial Lecture will be given by Professor R. S. Hotton on the evening of Thursday, April 9. Complete details of the technical sessions and other events, with reservation forms, may be obtained on application to the Conference Secretary at the headquarters of the Institute, 32 Great Ormond Street, London, W.C.1.

A Canadian Removal

Recent news from the Metal Sales Division of the Consolidated Mining and Smelting Company of Canada Ltd. is to the effect that their Toronto office is now located at 160 Bloor Street East, Toronto 5, Ontario.

Stolen Metal

A notification from the Wapping Police Station, Thames Division, Metropolitan Police, London, is to the effect that 58 ingots of tin, value £1,063, were stolen from a barge in the River Thames at Millwall, London, between February 13 and 14 last.

Thirty-four of these ingots are 22 in. long, 5 in. base, and stamped "Associated Lead." Shipping marks in ink on base, AG.9233 or KD.9233. Istambul. The other twenty-four ingots are 20 in. long, 3 in. base. Stamped on base, figure of a lamb with flag, and at the other end, "The Cornish Tin Research Smelting Co., Redruth." Refined tin, shipping marks, Shell, Istambul, in ink.

Smoke Eliminator

An important contribution towards cleaner air, particularly in so far as the smokeless operation of industrial boiler plant is concerned, is being made by a newly-established engineering concern which is now manufacturing under licence smoke eliminators designed and developed by the Fuel Research Station of the Department of Scientific and Industrial Research.

Apart from ensuring that smoke emitted conforms with statutory obligations under the Clean Air Act, the installation of these new eliminators is claimed to effect substantial savings.

Two types are currently available, one for natural draught hand-fired boilers, and the other for similar boilers with forced draught. The concern is also marketing a new smoke density indicator, also developed by the Fuel Research Station of D.S.I.R., which is said to provide a simple, efficient and immediate means of detecting the emission of dark smoke.

Visiting British Oxygen

The contribution of **British Oxygen Gases Limited** to the petroleum industry throughout the world will be shown to representatives of major oil companies and ancillary construction organizations next week. They will visit B.O.G.'s Sales and Technical Services Department at Cricklewood on February 24.

The representatives will see the latest techniques and equipment available for oil pipelines and plants, as well as the organization's world-wide distribution of equipment, spares and service facilities through associate companies and agents.

Pipe-cutting machines will be featured among the equipment on display at Cricklewood, which will include the Saffire blowpipe and Argonarc process. There will also be a film showing the latest techniques in the welding of aluminium and stainless steel.

U.S. Lead and Zinc Imports

A well-informed Department of Commerce source has told Comtelburo that an advisory group has been in operation for some months now, set up by the Cabinet-level Committee on Foreign Trade Policy, to study and propose changes in the Administration's lead and zinc import quota programme. This advisory committee, he said, was really a staff committee to the higher committee, and included officials from the State, Commerce, Interior and Treasury Departments. It was not a policy-making group.

This official indicated that the advisory committee has been studying requests by a number of foreign countries to be removed from the so-called "basket" categories (all other foreign countries category) and be assigned individual specific quarterly allowances. Other sources said these countries include Spain, Australia, Guatemala, Honduras and Italy, with Australia and Italy requesting assignment to specific allowances in other categories than the ones they have already been individually allotted.

The others have no specific quarterly assigned quotas. Importers handling lead and zinc from these "basket" category countries are on a first-come-first-served basis when the quarterly quotas are opened, and attempts are made to get these metals and ores into the country before being shut off.

Some sources said the committee hopes to have some quota modifications to accommodate these countries by the next quota period, beginning on April 1. The next international conference on lead and zinc is tentatively scheduled for April 28-May 1, probably in New York, United Nation sources confirmed.

It is understood the advisory group to the Cabinet-level Committee on foreign trade policy is also studying when the lead and zinc quota can be tightened to exclude specifically some manufactured lead and zinc products. However, it is believed in Washington circles that the President has not the authority to order an extension of the present limitations to include manufacturers. These sources see no way to tighten the present quotas short of another "escape clause" petition to the Tariff Commission by the industry, to include specifically some or all manufactured items of lead and zinc.

Change of Address

In the issue of this journal for February 6 (page 114) was noted a change of address of the offices and works of **Webley and Scott Ltd.** These are situate at Birmingham Road, West Bromwich, but we are asked by the firm to point out that the postal address is Park Lane, Handsworth, Birmingham, 21, and we shall be glad if readers would make a note of this.

Forthcoming Meetings

February 25—Institution of Production Engineers. Western Section. The Town Hall, Weston-super-Mare. "Metallic Materials Development." S. G. E. Nash. 7.30 p.m.

February 26 — Institute of Metals. Sheffield Local Section. Engineering Lecture Theatre, The University, St. George's Square, Sheffield, 1. "Symposium on "Corrosion." 2 p.m.

February 26—Southampton Metallurgical Society. Small Physics Lecture Theatre, The University, Southampton. "Gases in Metals." C. E. Ransley. 7.15 p.m.

February 26—Institution of Production Engineers. Rochester and District Graduate Section. The Sun Hotel, Chatham High Street, Chatham. "New Techniques in Non-Destructive Testing." W. G. Cook. 7.30 p.m.

February 27—Institute of Metal Finishing. Sheffield and North-East Branch. Grand Hotel, Cavendish Room, Sheffield. "Throwing Power." T. P. Hoar. 7 p.m.

February 27 — Institute of British Foundrymen. Tees-Side Branch. Teesdale Hall, Head, Wrightson and Co. Ltd., Thornaby-on-Tees. "Cupola Experiments." K. G. Harris. 7.30 p.m.

February 27 — Institute of British Foundrymen. West Wales Section. Landore, Swansea. "Modern Developments in Cupola Operation." R. H. Leyshon. 7 p.m.

February 27 — Institute of British Foundrymen. Falkirk Section. Temperance Café, Lint Riggs, Falkirk. "Cupola Practice." J. Lambie. 7.30 p.m.

Metal Market News

COPPER was outstanding last week on the Metal Exchange, and registered a useful advance to close at £238 for cash and £237 5s. 0d. three months on a turnover of about 12,500 tons. This meant a gain on the week of £5 5s. 0d. in cash and of £4 5s. 0d. in the forward position. A week ago there was a contango of 5s., but Friday's trading put on a backwardation of 15s. This development, together with a higher price, which however, closed below the best, was the result of news from the States that, as from to-day, February 20, all copper and copper-base alloys would be put back on the positive list. This means that the export of copper to the Soviet bloc from the United States will be barred, but apparently it also means that shipments to all other countries except Canada will require to be specially licensed. Here, there is obviously a threat to shipments of American copper in fulfilment of sales made on the London market, and it was not surprising to see the cash price advance sharply on Friday. Since November last it is believed that some 7,000 or 8,000 tons of copper have been shipped from the States to Russia and other Iron Curtain countries. Last Friday, a message despatched from Paris reported that the International Wrought Non-Ferrous Metals Council had taken steps towards achieving more stability in copper prices. Apparently, the idea is to provide the producers with statistical data in regard to the trend of consumption, etc., which would enable them to adjust their rate of production.

This is a laudable step towards the ironing out of some of the ups and downs in the copper price which so much plague the manufacturers, but whether the producers are sufficiently flexible in the conduct of their affairs to co-operate may be doubted. The question of stability is very much to the fore at the moment and, as mentioned last week, there is talk of some sort of a scheme for a "managed" price, but whether anything will ever come of this remains to be seen. The R.S.T. stability scheme is still fresh in people's minds, and it will be remembered that it was eventually abandoned, reportedly at the request of the consumers. At the beginning of last week, stocks of copper in L.M.E. warehouses were reported up by more than 800 tons, the largest increase for a long time past, and maybe they will go higher. It is much to be hoped they will, for a condition of backwardation is certainly no sort of a help to the London futures market.

The trend of values in tin last week was rather disappointing, for of late there has been a steady advance which has lifted the quotation a long way above the old support level of £730. After a turnover of 875 tons, cash closed £3 down at £769, while three months lost £2 10s. 0d. at £770. L.M.E. stocks continue to decline slowly week by week. Consumer buying is reasonably good, but rather less interest has come from America. Lead put up rather a poor show last week, to close at £69 10s. 0d. for the current month and £70 10s. 0d. for May. This means a loss of £1 7s. 6d. for prompt and of £1 for forward. The turnover was 8,925 tons. Some 8,350 tons of zinc changed hands last week, with little nett change to report in the price. The close was £73 15s. 0d. February, 10s. up, and £71 15s. 0d. May, 5s. down.

Birmingham

The most recent figures of unemployment in the Midland area show that the position is worse than it has been for twelve years. The total is now about 46,000, as compared with about 22,000 in January, 1958. Since the beginning of this year work in the building trade has been slowed up due to bad weather, and this accounts for quite a large proportion of the idle workers. It has also meant that buying of metal castings and fittings used in the industry has been adversely affected. Manufacturers of enamelled holloware have suffered a drop in orders, particularly in the export market, where they are faced with severe competition. On the other hand, the prosperity of the motor trade in Birmingham is such that it has prevented unemployment figures from being as high as they are in some other parts of the country, so that the rate is only 2·2 per cent as compared with a national average of 2·8. Activity in the electrical trades is responsible for a strong demand for copper wire.

In the iron and steel trade, sheet mills are still working to full capacity, and the outlook is better for some types of large sections and strip. Real revival, however, in other departments is still not in sight, and the continued running down of stocks is an indication of the reluctance of buyers to come into the market. Orders for heavy joists and sections are scarce, and the mills rolling these products are capable of a much larger output. There is also much unused capacity in the iron foundries.

New York

Week-end news was that copper was firm, with futures quite active. One well-informed source said that custom smelter copper was being sold quietly at 30½ cents per lb. This source said Brandeis Goldschmidt sold about 250,000 lb. of copper to the U.S. Philadelphia mint at 30·85 cents per lb. This is a premium copper, but indicates a custom smelter price of 30½ cents, he said. So far, custom smelters are still quoting 30 cents, but they noted they were reluctant to sell at that level. Producers indicated continued active demand. Tin was barely steady in the nearby deliveries, but very steady for the more distant positions. Sales were quiet. Lead was quiet, but zinc routine. A few leading sellers said the zinc price appears steady, since stocks are not over large and sales continue at steady daily pattern.

The Government has tightened up on copper exports to Russia and its satellites, the Commerce Department announced. In a reversal of a decision taken last November, the Commerce Department has put all copper and copper-base alloys back on its positive list. This, in effect, bars shipment of the metal to Soviet bloc countries. It also requires that shipments to all other countries, except Canada, be licensed individually by the Commerce Department. The regulations take effect on February 20 and cover 33 items, including copper wire and copper scrap.

Commerce Department officials said they took the action because an unexpectedly large number of applications had come in for shipment of copper to Russia and its European satellites since the U.S. lifted its previous ban last November 10. Since then, all copper shipments to the Soviet Union and its satellites had to get individual licences, but the Department approved the shipments almost as a matter of course. Now, it will be rare for the Agency to approve copper exports destined for the Soviet bloc.

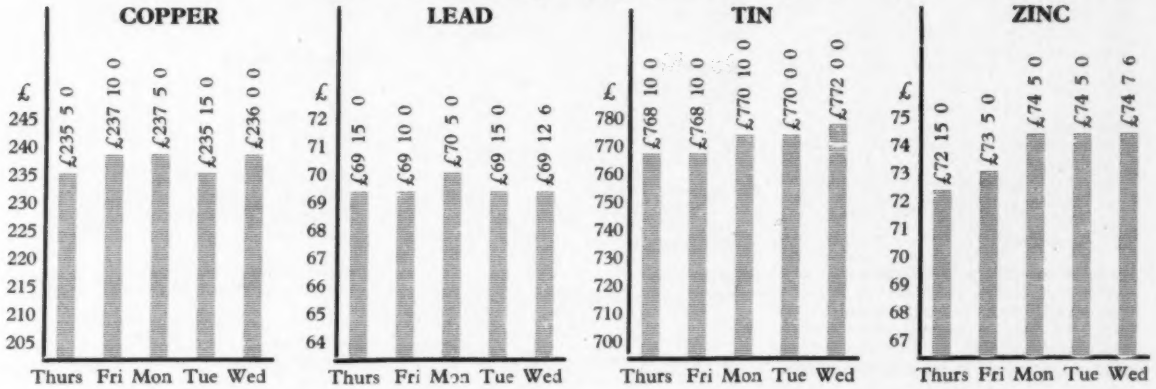
Applicants for U.S. export licences for copper and copper-base alloys must, from February 20, name the foreign consumer except for toll or conversion shipments of refined copper. This ruling was laid down at the same time as the new restrictions announced by the Commerce Department for copper exports to Russia and Eastern Europe. The new regulations take effect to-day, and cover refined copper, copper ores, mattes, concentrates, and other unrefined copper and copper scrap and copper-base alloy scrap.

Domestic production and imports of lead totalled about 85,200 short tons in November, and 86,000 tons were consumed, according to the Bureau of Mines, United States Department of the Interior. Of the new supply, primary refiners produced 36,600 tons of soft lead and 3,600 tons of lead in antimonial lead; secondary lead and copper smelters recovered 33,000 tons as metal and in alloys; and an estimated 12,000 tons of lead, as metal, were imported.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 12 February to Wednesday 18 February 1959



Primary Metals

All prices quoted are those available at 2 p.m. 18/2/59

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	6
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite	per unit		—	
Copper H.C. Electro	ton	236	0	0
Fire Refined 99·70%	„	235	0	0
Fire Refined 99·50%	„	234	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	9	8½
Indium	„		10	0
Iridium	„	20	0	0
Lanthanum	grm.		15	0
Lead English	ton	69	12	6
Magnesium Ingots	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal	ton	248	0	0
Mercury	flask	74	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	

		£	s.	d.
Palladium	oz.	5	15	0
Platinum	„	21	5	0
Rhodium	„	40	0	0
Ruthenium	„	14	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	5½
Tellurium	lb.		15	0
Tin	ton	772	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	73	5	7½
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	98	5	7½
Granulated 99·99+%	„	112	6	3

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏£/ton		**Canada** c/lb ≏£/ton		**France** fr/kg ≏£/ton		**Italy** lire/kg ≏£/ton		**Switzerland** fr/kg ≏£/ton		**United States** c/lb ≏£/ton	
Aluminium			22.50	185 17 6	210	157 10	375	221 5	2.50	212 10	26.80	214 10
Antimony 99.0					220	165 0	445	262 10			29.00	232 0
Cadmium					1,350	1,012 10					145.00	1,160 0
Copper												
Crude												
Wire bars 99.9							450	265 10				
Electrolytic	32.50	239 10	29.00	239 10	326	244 10			2.85	242 5	30.00	240 0
Lead			11.00	90 17 6	102	76 10	168	99 2 6	.90	76 10	11.50	92 0
Magnesium												
Nickel			70.00	578 5	900	675 0	1,200	708 0	7.50	637 10	74.00	592 0
Tin	110.75	815 2 6			1,104	828 0	1,480	873 5	9.15	777 15	102.00	816 0
Zinc												
Prime western			11.25	93 0 0							11.50	92 0
High grade 99.95			11.85	97 17 6								
High grade 99.99			12.25	101 2 6								
Thermic					108.00	81 0						
Electrolytic					116.00	87 0	167	98 10 0	.94	81 0	12.75	102 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 18/2/59

		£	s.	d.
Aluminium Alloy (Virgin)				
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	142	10	0
B.S. 1490 L.M.2	„	152	0	0
B.S. 1490 L.M.4	„	169	0	0
B.S. 1490 L.M.6	„	186	0	0
†Average selling prices for mid October				
***Aluminium Bronze**				
BSS 1400 AB.1	ton	226	0	0
BSS 1400 AB.2	„	245	0	0
***Brass**				
BSS 1400-B3 65/35	ton	152	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„	204	0	0
***Gunmetal**				
R.C.H. 3/4%	ton		—	
(85/5/5/5)	„	187	0	0
(86/7/5/2)	„	197	0	0
(88/10/2/1)	„	239	0	0
(88/10/2/½)	„	255	0	0
Manganese Bronze				
BSS 1400 HTB1	„	189	0	0
BSS 1400 HTB2	„	195	0	0
BSS 1400 HTB3	„	212	0	0
Nickel Silver				
Casting Quality 12%	„	215	0	0
„ „ 16%	„	225	0	0
„ „ 18%	„	240	0	0
***Phosphor Bronze**				
B.S. 1400 P.B.1. (A.I.D. released)	„	282	0	0
B.S. 1400 L.P.B.1	„	206	0	0
Phosphor Copper				
10%	ton	250	0	0
15%	„	253	0	0
Phosphor Tin				
5%	„		—	
Silicon Bronze				
BSS 1400-SB1	„	245	0	0
Solder, soft, BSS 219				
Grade C Tinmans	„	363	15	0
Grade D Plumbers	„	293	10	0
Grade M	„	399	0	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	105	11	3
Mazak V	„	109	11	3
Kayem	„	115	11	3
Kayem II	„	121	11	3
Sodium-Zinc	lb.		2	6

*Average prices for the last week-end.

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

		£	s.	d.
Aluminium				
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	„		2	10½
Sheet 24 S.W.G.	„		3	1½
Strip 10 S.W.G.	„		2	8½
Strip 18 S.W.G.	„		2	9½
Strip 24 S.W.G.	„		2	11
Circles 22 S.W.G.	„		3	2½
Circles 18 S.W.G.	„		3	1½
Circles 12 S.W.G.	„		3	0½
Plate as rolled	„		2	8
Sections	„		3	2
Wire 10 S.W.G.	„		2	11½
Tubes 1 in. o.d. 16 S.W.G.	„		4	1
Aluminium Alloys				
BS1470. HS10W.	„			
Sheet 10 S.W.G.	„		3	1
Sheet 18 S.W.G.	„		3	3½
Sheet 24 S.W.G.	„		3	11
Strip 10 S.W.G.	„		3	1
Strip 18 S.W.G.	„		3	2½
Strip 24 S.W.G.	„		3	10½
BS1477. HP30M. Plate as rolled	„		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	„		3	9½
Sheet 18 S.W.G.	„		4	2
Sheet 24 S.W.G.	„		5	0½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	2
Strip 24 S.W.G.	„		4	9½
BS1477. HPC15WP. Plate heat treated	„		3	6½
BS1475. HG10W. Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP. Tubes 1 in. o.d. 16 S.W.G.	„		5	0½
BS1476. HE10WP. Sections	„		3	1½
Brass				
Tubes	„		1	10⅝
Brazed Tubes	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	253	10	0
Extruded Bar	lb.		2	0½
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	189	0	0
Brass				
Condenser Plate (Naval Brass)	ton	200	0	0
Wire	lb.		2	7⅛
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Copper				
Tubes	lb.		2	3½
Sheet	ton	268	0	0
Strip	„	268	0	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	287	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	7
Lead				
Pipes (London)	ton	112	5	0
Sheet (London)	„	110	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7%	lb.		3	8
Wire 10%	„		4	2¾
Phosphor Bronze				
Wire	„		4	1½
Titanium (1,000 lb. lots)				
Billet over 4″ dia.-18″ dia.	lb.	63/-		64/-
Rod 4″ dia.-·250″ dia.	„	75/-		112/-
Wire under ·250″ dia.-·036″ dia.	„	146/-		222/-
Sheet 8′ × 2′ × ·250″-·010″	„	88/-		157/-
Strip ·048″-·003″	„	100/-		350/-
Tube	„			300/-
Extrusions	„			120/-
Zinc				
Sheet	ton	109	10	0
Strip	„		nom.	

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 17/2/59.

	£
Aluminium	
New Cuttings	145
Old Rolled	125
Segregated Turnings	94
Brass	
Cuttings	158
Rod Ends	142
Heavy Yellow	117
Light	112
Rolled	148
Collected Scrap	115
Turnings	136
Copper	
Wire	210
Firebox, cut up	204
Heavy	200
Light	195
Cuttings	210
Turnings	190
Braziery	162
Gunmetal	
Gear Wheels	185
Admiralty	185
Commercial	162
Turnings	157
Lead	
Scrap	60
Nickel	
Cuttings	—
Anodes	530
Phosphor Bronze	
Scrap	162
Turnings	157
Zinc	
Remelted	55
Cuttings	47
Old Zinc	37

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of Dec., 1958, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follow in long tons:—

COPPER	Gross Weight	Copper Content
Wire	27,365	27,032
Rods, bars and sections	11,855	7,854
Sheet, strips and plate	11,487	9,087
Tubes	6,424	5,950
Castings and miscellaneous	7,258	—
Sulphate	3,355	—
	67,744	56,698
Of which:		
Consumption of Virgin Copper		45,968
Consumption of Copper and Alloy Scrap (Copper Content)		10,730

LEAD	
Cables	8,148
Batteries	2,505
Battery Oxides	1,790
Tetra Ethyl Lead	1,953
Other Oxides and Compounds	2,012
White Lead	614
Shot	362
Sheet and Pipe	5,055
Foil and Collapsible Tubes	297
Other Rolled and Extruded	486
Solder	1,125
Alloys	1,699
Miscellaneous Uses	1,108
Total	27,154

TIN	
Tinplate	988
Tinning:	
Copper Wire	46
Steel Wire	10
All other	62
Solder	146
Alloys	417
Foil and Collapsible Tubes, etc.	47
Tin Compounds and Salts	76
Miscellaneous Uses	10
Total Consumption	1,802

ZINC	
Galvanizing	7,952
Brass	7,926
Rolled Zinc	1,793
Zinc Oxide	2,225
Zinc Die-casting alloy	4,386
Zinc Dust	848
Miscellaneous Uses	912
Total, All Trades	26,042
Of which:	
High purity 99·99 per cent	4,597
Electrolytic and high grade 99·95 per cent	4,619
Prime Western, G.O.B. and debased	9,421
Remelted	397
Scrap Brass and other Cu alloys	4,183
Scrap Zinc, alloys and residues	2,596

ANTIMONY	
Batteries	78
Other Antimonial Lead	53
Bearings	29
Oxides—for White Pigments	124
Oxides—other	80
Miscellaneous Uses	15
Sulphides	8
Total Consumption	387
Antimony in Scrap	
For Antimonial Lead	358
For Other Uses	13
Total Consumption	371

CADMIUM	
Plating Anodes	55·20
Plating Salts	6·55
Alloys: Cadmium Copper	4·95
Alloys: Other	2·60
Batteries: Alkaline	4·90
Batteries: Dry	0·40
Solder	4·15
Colours	12·65
Miscellaneous Uses	1·00
Total Consumption	92·40

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£192.15.0)	220
Heavy copper	(£188.7.6)	215
Light copper	(£162.0.0)	185
Heavy brass	(£109.10.0)	125
Light brass	(£87.12.6)	100
Soft lead scrap	(£56.0.0)	64
Zinc scrap	(£39.10.0)	45
Used aluminium unsorted	(£78.16.0)	90
France (francs per kilo):		
Copper	(£195.0.0)	260
Heavy copper	(£195.0.0)	260
Light brass	(£116.5.0)	155
Zinc castings	(£47.5.0)	63
Lead	(£67.10.0)	90
Tin	—	
Aluminium	(£101.5.0)	135

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£80.5.0)	136
Lead, battery plates	(£44.17.6)	76
Copper, first grade	(£209.10.0)	355
Copper, second grade	(£197.12.6)	335
Bronze, first quality machinery	(£203.10.0)	345
Bronze, commercial gunmetal	(£174.0.0)	295
Brass, heavy	(£138.12.6)	235
Brass, light	(£126.17.6)	215
Brass, bar turnings	(£129.17.6)	220
New zinc sheet clippings	(£57.5.0)	97
Old zinc	(£42.10.0)	72

Financial News

Copper Prices

Steps towards more stable copper prices were decided upon by the International Wrought Non-Ferrous Metals Council in Paris on Thursday of last week. This was disclosed in a communique after a meeting of the Council's Steering Committee, under the chairmanship of Mr. C. A. Jacobssen, of Sweden.

The communique said that non-ferrous metal fabricators from thirteen West European countries had decided that statistical data should be made available to copper producers in the hope that this would improve flexibility in copper production, and thus help to bring about a greater degree of price stability. This information would include the trend of orders booked, monthly copper consumption figures, studies on substitutes for copper and a review of the trend of trade.

The meeting, attended by representatives from Austria, Belgium, Denmark, Finland, France, West Germany, Britain, Holland, Italy, Norway, Portugal, Sweden and Switzerland, had also discussed the trend of trade and export business. The slow rate of progress in the field of standardization had aroused the Council's concern, and it was noted that member countries of the Council had informed their national standards organizations of this.

The communique also said that liaison with the Non-Ferrous Metals Committee of the O.E.E.C. continued to be maintained, and it was hoped to assist that organization with statistical and other information in the preparation of its periodic surveys of the non-ferrous metals industry in Europe. Council sources said after the meeting that rumours about discussion of an "African copper price" were unfounded. This question had not been considered. They pointed out that the meeting had been attended by fabricators only, and no producers had been present.

Offer for Avo

It has been announced by Metal Industries Ltd. that it has made an offer for the whole of the share capital of Avo Limited, manufacturers of electric and electronic instruments and coil-winding machines, and that this offer has been accepted in principle by the directors of Avo Limited. The terms of the offer are, briefly, 10s. in cash for each 2s. Ordinary share in Avo Limited, or, alternatively, one new Ordinary share of £1 in Metal Industries Limited for every four shares in Avo Limited.

Substantial shareholders, holding not less than 60 per cent of the issued share capital of Avo Limited, have indicated that they will accept the offer for cash. Details of the offer will be announced shortly, with a recommendation from the board of Avo Limited that it should be accepted.

Platinum Price

Johnson, Matthey and Company Limited have, with effect from Tuesday last, raised its price of platinum to £21¼ from £19½ per troy ounce.

British Oxygen Co. Ltd.

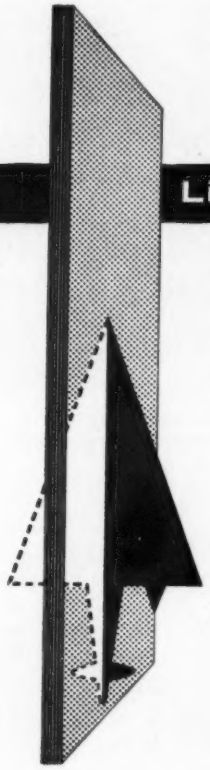
Results to year ending September 30 last show group trading profit, after charging depreciation £4,094,653, at £7,224,500. The directors recommend a final dividend of 6 per cent on the Ordinary stock, which, with the interim dividend, makes a total dividend for the year of 10 per cent less tax.

THE STOCK EXCHANGE

Steady Advance Continued Throughout Industrial Share Market

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 17 FEBRUARY	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	24/7½	—3d.	9	10	7 6 0	24/10½	23/3	24/9	17/6
400,000	2/–	Anti-Attrition Metal	1/6		4	8½	5 6 9	—	—	1/9	1/3
41,305,038	Stk. (£1)	Associated Electrical Industries ...	54/9	+9d.	15	15	5 9 6	59/–	54/–	58/9	46/6
1,609,032	1	Birfield	57/6		15	15	5 1 6	59/–	57/1½	62/4½	46/3
3,196,667	1	Birmid Industries	72/6	—3d.	17½	17½	4 16 6	76/10½	72/6	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	37/1½	+7½d.	11	10	5 18 6	40/4½	36/6	39/–	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/–		5	5	6 13 3	—	—	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	27/6		10	12½	7 5 6	28/3	27/6	28/9	24/–
300,000	1	Ditto Pref. 5%	15/–		5	5	6 13 3	15/3	15/–	16/–	15/–
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6		7	7	6 16 6	—	—	20/4½	19/–
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	18/9	—6d.	6	6	6 8 0	19/7½	18/9	20/–	18/4½
15,000,000	Stk. (£1)	British Insulated Callender's Cables	48/3	—3d.	12½	12½	5 3 6	52/–	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	52/–	+1/9	10	10	3 17 0	54/7½	49/3	52/–	28/3
600,000	Stk. (5/–)	Canning (W.) & Co.	24/9	—3d.	25+ *2½C	25	5 1 0	25/6	24/9	25/3	19/3
60,484	1/–	Carr (Chas.)	1/6		12½	25	8 6 9	—	—	2/3	1/4½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/9	+1½d.	25	25	10 10 6	5/0½	4/7½	5/3	4/–
555,000	1	Clifford (Chas.) Ltd.	22/6		10	10	8 17 9	22/6	22/6	22/–	16/–
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	—	—	16/–	15/–
250,000	2/–	Coley Metals	3/3	+3d.	20	25	12 6 3	3/3	2/10½	4/6	2/6
8,730,596	1	Cons. Zinc Corp.†	62/3	—1/3	18½	22½	6 0 6	67/6	61/3	65/3	41/–
1,509,528	1	Davy & United	92/9	+3d.	20	15	4 6 3	92/9	86/–	87/–	45/9
2,915,000	5/–	Delta Metal	26/7	+3d.	30	*17½	5 12 3	26/9	24/1½	25/–	17/7½
4,600,000	Stk. (£1)	Enfield Rolling Mills Ltd.	44/6	—2/–	12½	15B	5 12 3	46/6	36/7½	38/–	22/9
750,000	1	Evered & Co.	31/–	+1/–	15Z	15	6 9 0	31/–	30/–	30/–	26/–
18,000,000	Stk. (£1)	General Electric Co.	32/10½	+7½d.	10P	12½		40/3	32/3	40/6	29/6
1,500,000	Stk. (10/–)	General Refractories Ltd.	38/3		20	17½	5 4 0	38/7½	37/3	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	65/–		15	15	4 12 3	66/6	65/–	67/6	61/–
750,000	5/–	Glacier Metal Co. Ltd.	6/9		11½	11½	8 10 3	7/1½	6/7½	8/3	5/–
1,750,000	5/–	Glynwed Tubes	18/10½	—3d.	20	20	5 6 0	19/3	16/4½	18/1½	12/10½
5,421,049	10/–	Goodlass Wall & Lead Industries ...	30/3	+3d.	13‖	18Z	4 6 0	31/6	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	79/6	—1/–	20	17½	5 0 6	83/9	75/–	57/9	45/–
396,000	5/–	Harrison (B'ham) Ord.	15/3		*15	*15	4 18 3	15/3	15/–	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	—	—	19/9	18/4½
1,075,167	5/–	Heenan Group	7/6	—1½d.	10	10‡	6 13 3	8/3	7/6	9/7½	6/9
236,958,260	Stk. (£1)	Imperial Chemical Industries ...	34/10½	+9d.	12Z	10	4 11 9	38/3	33/9	38/–	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/9		5	5	5 19 6	16/9	16/–	17/1½	16/–
14,584,025	••	International Nickel	163½	+3	$2.60	$3.75	2 17 0	163½	153	169	132‡
860,000	5/–	Jenks (E. P.), Ltd.	9/1½	—7½d.	14	27½¢	7 13 6	10/–	8/9	10/–	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/3	15/4½	16/9	15/–
3,987,435	1	Ditto Ord.	45/6		10	10	4 8 0	45/6	44/3	47/–	36/6
600,000	10/–	Keith, Blackman	27/6		17½E	15	6 7 3	27/6	25/–	28/9	15/–
320,000	4/–	London Aluminium	5/6		10	10	7 5 6	6/–	5/3	6/–	3/–
2,400,000	1	London Elec. Wire & Smith's Ord. ...	70/–		15	12½	4 5 9	74/6	70/6	74/–	39/9
400,000	1	Ditto Pref.	24/9		7½	7½	6 1 3	25/3	24/3	24/3	22/–
765,012	1	McKechnie Brothers Ord.	43/3	—1/9	15	15	6 18 6	45/–	43/3	45/–	32/–
1,530,024	1	Ditto A Ord.	41/3	—1/3	15	15	7 5 6	43/6	41/3	45/–	30/–
1,108,268	5/–	Manganese Bronze & Brass	14/3		20	27½‡	7 0 3	14/3	13/9	14/1½	8/9
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	71/3	+2/3	11	11	3 1 9	73/9	66/6	73/3	40/6
415,760	Stk. (2/–)	Metal Traders	8/6		50	50	11 15 3	9/1½	1/6	9/–	6/3
160,000	1	Mint (The) Birmingham	22/–		10	10	9 1 9	22/–	22/–	22/9	19/–
80,000	5	Ditto Pref. 6%	70/6		6	6	8 10 3	75/6	69/–	83/6	69/–
3,705,670	Stk. (£1)	Morgan Crucible A	43/6		10	10	4 12 0	45/9	43/6	45/–	34/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	18/–		5½	5½	6 2 3	18/6	18/–	18/–	17/–
2,200,000	Stk. (£1)	Murex	43/9	—9d.	17½	20	8 0 0	48/6	42/–	58/9	46/–
468,000	5/–	Ratcliffs (Great Bridge)	10/4½	—4½d.	10	10	4 16 6	11/3	10/4½	11/1½	6/10½
234 960	10/–	Sanderson Bros. & Newbould ...	28/3	+6d.	20	27½D	7 1 6	28/3	27/9	27/3	24/6
1,365,000	Stk. (5/–)	Serck	18/1½		15	17½	4 2 9	19/–	18/–	18/7½	11/–
6,698,586	Stk. (£1)	Stone-Platt Industries	43/3	+3d.	15	12½	6 18 9	46/9	43/3	45/6	22/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	16/1½		5½	5½	6 16 6	16/7½	15/10½	16/3	12/7½
18,255,218	Stk. (£1)	Tube Investments Ord.	82/6	+2/6	17½	15	4 5 0	83/3	72/–	86/–	48/4½
41,000,000	Stk. (£1)	Vickers	34/3	+3d.	10	10	5 16 9	37/–	34/–	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	15/–		5	5	6 13 3	15/0½	14/7½	15/9	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	22/–	—3d.	*5	*5	7 0 0A	22/7½	21/7½	23/–	21/3
2,200,000	1	Ward (Thos. W.), Ord.	84/–	+6d.	20	15	4 15 3	87/6	83/6	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	41/9	+6d.	10	10	4 15 9	47/–	39/9	46/6	32/6
225,000	2/–	Wolverhampton Die-Casting ...	8/10½		30	25	6 15 3	9/–	8/8½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	22/6	+3d.	27½	27½	6 2 0	22/6	21/6	22/9	14/9
78,465	2/6	Wright, Bindley & Gell	5/6	+3d.	20	20	9 1 9	5/6	4/11½	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/–		6	6	9 4 6	—	—	13/–	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/10½		27	40D	9 8 0	3/–	2/9	3/1½	2/7½

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. •The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ¢ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits. E and 50% Capitalized issue in 7% 2nd Pref. Shares. P Interim dividend since reduced.



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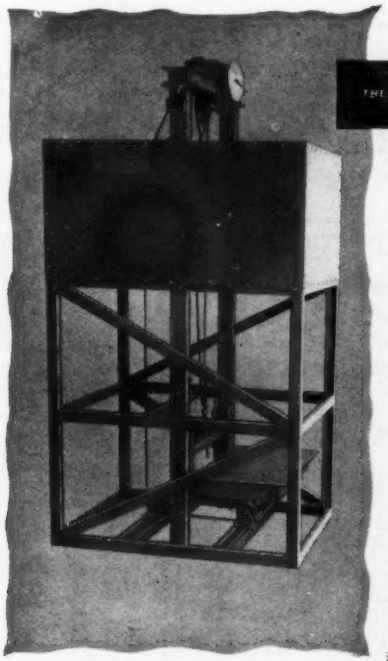

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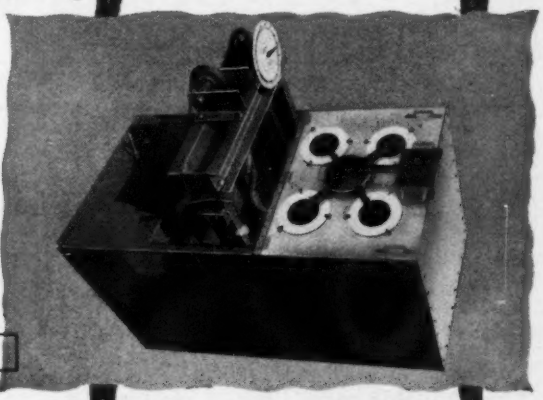

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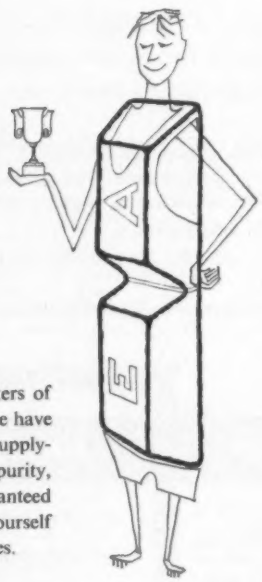

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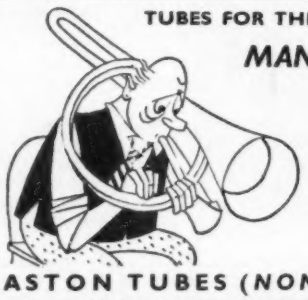

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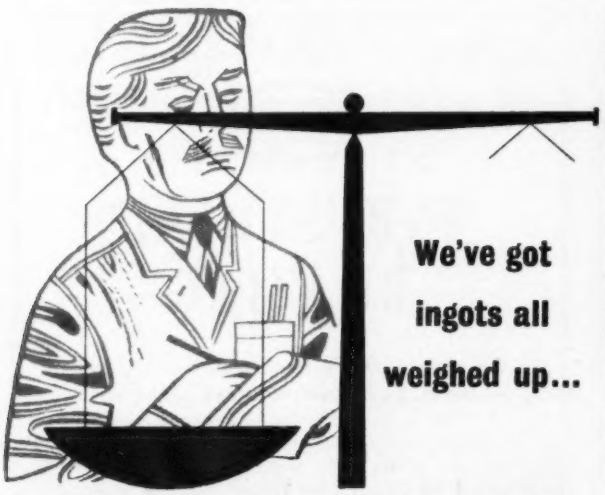

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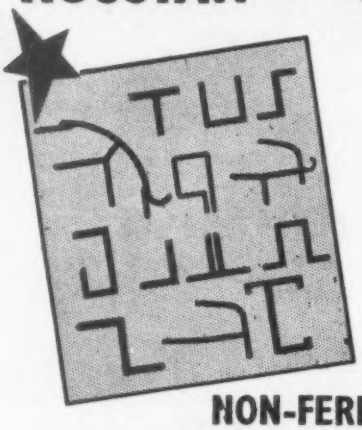

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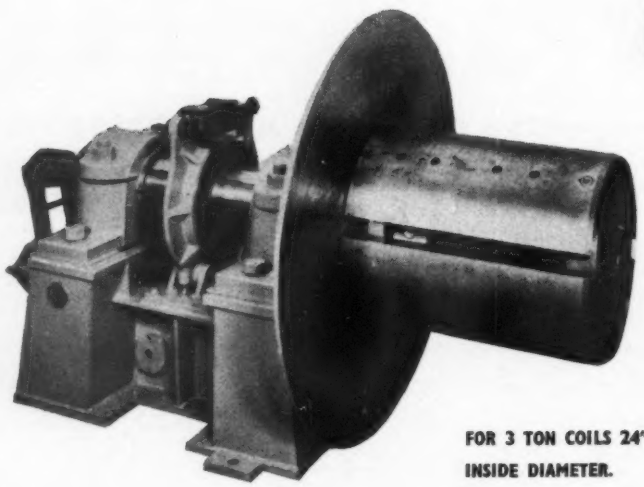

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